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# MYCOLOGIA

EDITOR  
FRED JAY SEAVER

Volume XXIV, 1932  
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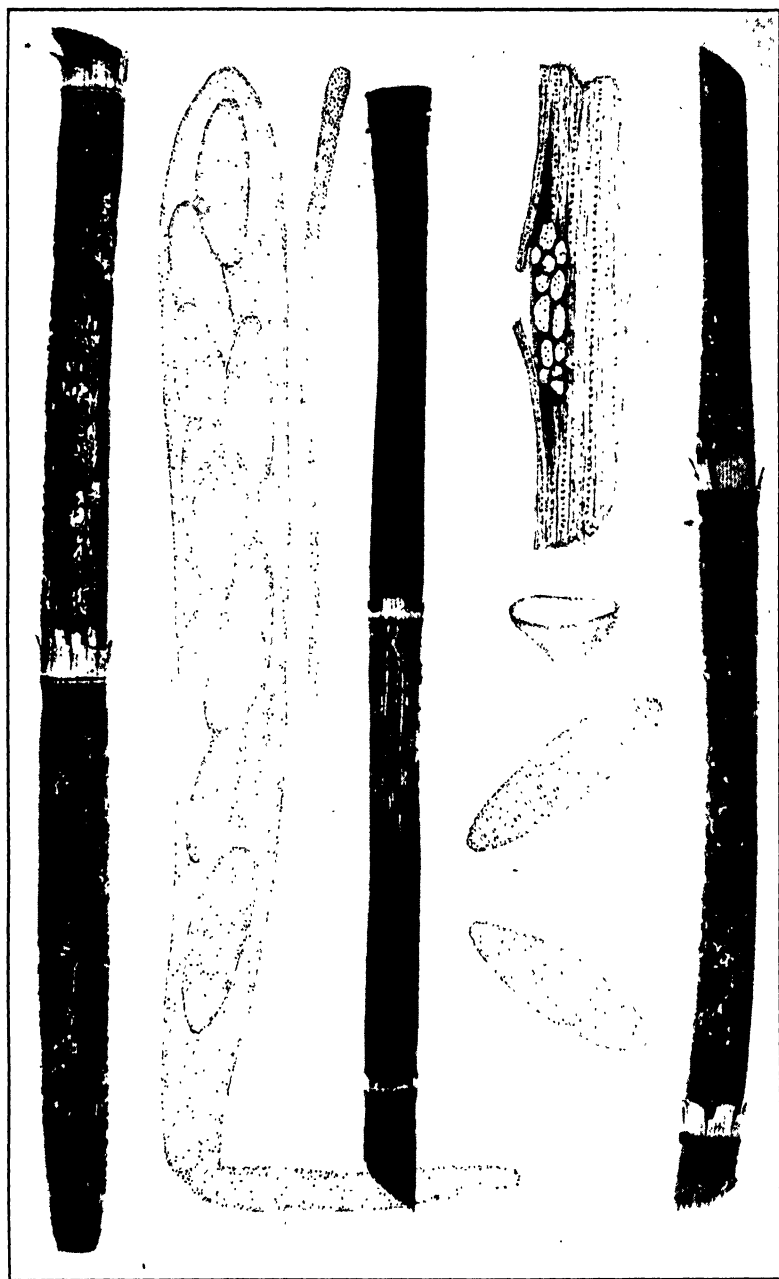
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STAMNARIA AMERICANA

# MYCOLOGIA

VOL. XXIV

JAN.-FEB., 1932

No. 1

## PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XVI. STAMNARIA<sup>1</sup>

FRED J. SEAVER

(WITH PLATE 1)

The genus *Stamnaria* was founded by Fuckel on *Peziza Personii* which is synonymous with the previously described *Lycoperdon Equiseti* Hoffman. The species which is apparently of common occurrence in Europe has also been frequently reported from North America.

In 1902, Masee and Morgan described a new species, *Stamnaria americana*, which, according to them, was distinguished from the European form by the much larger asci and spores. In 1907 a specimen was sent to the writer from Terre Haute, Indiana, which was referred to *Stamnaria americana* Masee and Morgan. No further attention was given to the matter until the winter of 1931 when the writer received from Dr. J. H. Schaffner another large collection of the American species on *Equisetum*.

Since at this time a detailed study of the genus had been undertaken, preliminary to the monograph of the inoperculate cup-fungi, all the American specimens on *Equisetum* in our collection have been gone over carefully. So far as ascertained, all of these specimens have the characteristic large spores of *Stamnaria americana*. There is considerable variation in the size of the spores

<sup>1</sup> This paper is preliminary to a monograph of North American Cup-fungi (inoperculates), a companion volume to North American Cup-fungi (operculates), which was published by the author and issued in December, 1928.

and it may be that this is only a form of the European species. However, the difference in size of the spores and asci is so marked that it cannot be overlooked and we are therefore referring all of our American forms to that species.

It seems to the writer that this species should be included with the Cenangiaceae instead of the Bulgariaceae as has been done by some authors on account of the subgelatinous nature of the apothecia when moist. The general habits of the plants and spore characters all indicate a relationship with that family.

Since very little has been published on this species in America, this opportunity is taken to publish description, photograph and drawings based on the collection sent by Dr. J. H. Schaffner from Ohio. Dr. Schaffner states that the fungus is very destructive to the host plants which occur in a large patch consisting of several acres. He also states: "The cavities of this horsetail are more or less filled with free water all winter long, and the fungus seems to thrive, especially in the fall of the year."

STAMNARIA Fuckel, Symb. Myc. 309. 1869

Apothecia erumpent-superficial, occurring singly or more often in cespitose clusters, more or less gelatinous, horny when dry, sessile or short-stipitate; asci clavate, usually 8-spored; spores simple ellipsoid, hyaline; paraphyses filiform, slightly enlarged above.

Type species, *Peziza Persoonii* Moug.

STAMNARIA AMERICANA Massee & Morgan, Jour. Myc. 8: 183.  
1902

*Gloeosporium Equiseti* Ellis & Ev. Jour. Myc. 4: 52. 1888.

Apothecia erumpent in clusters of 3-4 each or in rows 6-7 mm. long, the individual apothecia sessile or subsessile, at first rounded, gradually expanding and becoming turbinate, reaching a diameter of .5-7 mm., pale-orange; hymenium plane or slightly concave, similar in color to the outside of the apothecium, whitish pruinose from the ends of the protruding asci and paraphyses; asci clavate, 8-spored, reaching a length of 150-200  $\mu$  and a diameter of 16  $\mu$ ; spores 1-seriate or partially 2-seriate above, ellipsoid, straight or curved, usually with one or two large oil-drops surrounded with a granular contents, hyaline, 7-9  $\times$  24-32  $\mu$ ; paraphyses filiform, rather strongly enlarged above, pale-orange in mass.

On species of *Equisetum*: *E. arvense*, *E. hyemale*, *E. laevigatum*, and *E. robustum*.

TYPE LOCALITY: Preston, Ohio.

DISTRIBUTION: New York and New Jersey to Indiana and (Oregon?).

EXSICCATI: N. Am. Fungi 1274 (as *Peziza Persoonii*) 2275, 2449 (conidial stage); Fungi Columb. 333 (as *Stamnaria Equiseti*); 1349 (conidial stage); Kellerm. Ohio Fungi 18.

Since this article was sent to the printer an additional collection on the conidial stage of this fungus, *Glocosporium Equiseti*, was sent to the writer by Dr. J. H. Schaffner from Yosemite Valley, California.

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# A POWDERY MILDEW ON COTTON FROM PERU

E. V. ABBOTT

(WITH 1 TEXT FIGURE)

Powdery mildew is one of the most common diseases of cotton in Peru, occurring in all of the cotton-growing valleys of the coastal region where cotton is a major crop. In spite of its wide distribution and the heavy infections which frequently occur, however, it is of minor economic importance.

The disease is characterized by the appearance of scattered, circular patches of mycelium, first on the lower and later on the upper surfaces of the leaves. The patches are usually numerous and enlarge until they coalesce to cover the entire leaf surface. When a large part of the leaf is covered by the mildew, it curls slightly, frequently turns yellowish, and may finally fall. Late in the season the heavy growth of the fungus on the leaves sometimes gives the fields the appearance of being covered with a light fall of snow, giving rise to the local common name for the disease of "manta blanca" or white mantle. Although such heavy infections may cause partial defoliation, little damage results because of the advanced stage of maturity of the plants.

Field observations have shown that several North American varieties of cotton are more susceptible to the disease than either the native Peruvian cotton (*Gossypium peruvianum*) or the hybrid Tanguis, which is the principal commercial variety of the country. The heaviest infections have been noted on Acala. Pima, Delfos, Express and Super Seven are also susceptible. Because of the minor economic importance of the disease no control measures are suggested.

The causal fungus has been identified as *Erysiphe Malachrae* Seaver after comparison of Peruvian collections with type material collected by Dr. N. L. Britton and F. S. Earle March 11, 1922 (Expl. of Porto Rico 6488), kindly furnished by Dr. Seaver. Both the imperfect and perfect stages usually occur in the field.

The conidial stage is limited almost entirely to the lower leaf surfaces while the *Erysiphe* stage is most abundant on the upper surfaces. In Piura, the northernmost cotton-growing section of Peru, where the climate is much hotter and drier than in the valleys to the south and where Pima is grown almost exclusively, the writer has not observed the *Erysiphe* stage. In the other valleys both stages have always been found together, on Pima as well as on other varieties, indicating that the absence of the perfect stage from Piura is the result of climatic rather than varietal influences.

The conidial stage is believed to be *Ovulariopsis Gossypii* Wake-



FIG. 1. Photomicrograph of *Erysiphe Malachrae*, *a*, perithecium showing rudimentary appendages; *b*, perithecium discharging asci; *c*, ascus with ascospores. ( $\times 350$ .)

field. While direct comparison with material of the West Indian mildew has not been made, Wakefield's description of the disease and figure of the fungus agree so closely with the writer's notes on the Peruvian disease that it appears very probable they are the same. The conidia of the Peruvian fungus are elongate elliptical, muticate, 35 to 60  $\mu$  by 14 to 30  $\mu$ , with finely granular contents.

It is interesting to note that this is the only *Erysiphe* collected in Peru by the writer, although the conidial stages of several powdery mildews were collected on 36 species of cultivated and 11 species of uncultivated plants. It is a rare instance of the occurrence of *Erysiphe* in the tropics.

## LITERATURE CITED

- Seaver, Fred J.** Sci. Surv. Porto Rico and Virgin Islands **8**: 27. 1926.  
**Wakefield, E. M.** On two species of *Oculariopsis* from the West Indies.  
Kew Bull. Misc. Information 1920, p. 235-238.

DEPARTMENT OF PLANT PATHOLOGY,  
ESTACION EXPERIMENTAL AGRICOLA,  
LIMA, PERU

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EDITOR'S NOTE

It is interesting to note that this powdery mildew which was first observed on a malvaceous weed in Porto Rico should later be found on cultivated cotton in such a remote region as Peru. Although the conidial stage of several species of powdery mildew is quite abundant in Porto Rico on a number of hosts, so far as the writer is aware, this is the first time that any have been found there in perfect fruit. Neither has any subsequent collection been obtained although a special search has recently been made for it by C. E. Chardon, who collaborated with the writer in the survey of the fungi of Porto Rico.

# CROSSING HERMAPHRODITIC RACES OF NEUROSPORA

B. O. DODGE

(WITH 3 TEXT FIGURES)

In the account "Inheritance of the albinistic non-conidial characters in interspecific hybrids in *Neurospora*,"<sup>1</sup> there were described a number of plate cultures in which were grown two different hermaphroditic races. Some combinations resulted in the production of ascocarps along the meeting line in addition to those formed about the points of inoculation. The irregularities in spore numbers in asci from the perithecia along the line were such as to suggest in some cases that the two races had hybridized. Individual asci had not been analyzed thoroughly to prove this, however. Later many more combinations were made and cultures were obtained from all of the spores from individual asci. The results prove that in many combinations the line ascocarps were purely the product of the one or the other race through self-fertilization. In other words, two hermaphroditic races of *Neurospora* each of which is more or less self sterile may become more self fertile when grown opposite each other. It has been found for other ascomycetes also that fruit bodies often develop where two mycelia meet because of nutritive conditions and without involving cross fertilization.

Crossing *Neurospora sitophila* and *N. tetrasperma*, gives larger perithecia than either parent, but this should not mislead one as to the nature of the exceptionally large perithecia formed where two hermaphroditic races such as "Tet" and "4A<sub>5</sub>" meet. Straight *N. tetrasperma* which is conidial and hermaphroditic, and 1A<sub>7</sub> which is non-conidial and hermaphroditic,<sup>1</sup> grown opposite each other, gave four kinds of ascocarps. Each race produced its own fruit bodies by self-fertilization. Over on the *N. tetrasperma* side of the line were scattered here and there exceptionally large perithecia. A few of their asci were analyzed

<sup>1</sup> Mycologia 23: 1-50. 1931.



Each had four nuclei carrying the + C factors for conidia and the other four were non-conidial. Other ascocarps of intermediate size taken from the central line were also proved to be hybrids. Most of the pairs of hermaphroditic races grown together so far, however, did not hybridize where their mycelia met.

On the other hand when a unisexual race such as  $S_1$ ,  $S_8$ , 22 or 34 is grown opposite hermaphroditic races like 3C or 1A, hybrids are usually produced along the meeting line as was noted in the paper cited above. The diagram (FIG. 1) shows how this was

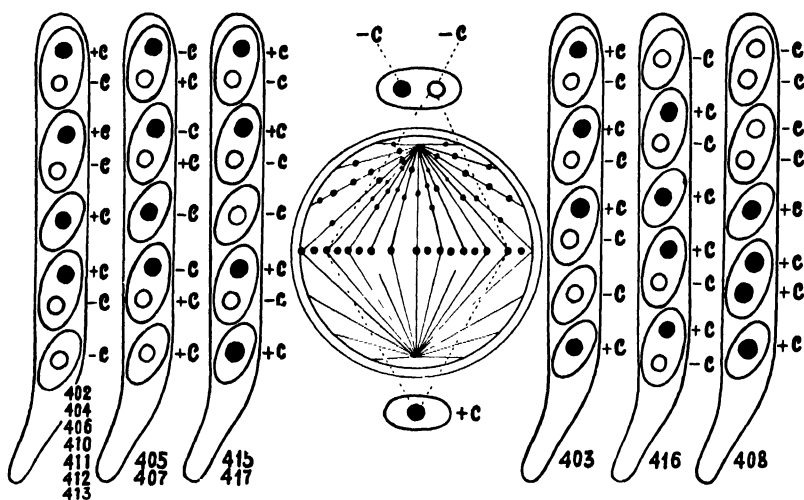


FIG. 1. Results of crossing race 3C, which is hermaphroditic and non-conidial ( $-c$ ), and  $S_1$  one of the unisexual components of *Neurospora tetrasperma*; it is of sex B and conidial ( $+C$ ). Only 5-spored asci are diagrammed. Sex A nuclei are shown as white circles, sex B as black circles. Most of the asci from this cross are 4-spored. See text for further explanation.

proved. These races, when mated, produce mostly 4-spored asci, but there are always a few 5-spored asci in each perithecium. The latter are selected for study because once the nature of the two little spores is determined it is not always necessary to culture the large spores. Race 3C is non-conidial and hermaphroditic. Race  $S_1$  is conidial and of sex B. It is clear that ascospores from 3C alone through self fertilization can not produce mycelia which bear conidia. Any ascus in which it is proved by cultures that

four of the original eight nuclei were conidial and the other four non-conidial must have been a hybrid between 3C and  $S_1$ . Cross fertilization is here more potent than selfing.

It is interesting to note that in thirteen out of the fourteen asci diagramed here, one of the small spores lies at the lower end of the ascus. The fact that a large spore usually lies between the two little spores is easily accounted for by the irregular orientation of the spindles of the third nuclear divisions. This point will be explained by Dr. Carl C. Lindgren through whose courtesy the diagram slightly modified for the present purposes is published here also. At the right the diagram shows that all of the spores will be unisexual provided the sex factors segregate in the second division and as the spindles elongate the two nuclei of the same sex move in the same direction. This peculiarity has been discussed in previous papers, and Kniep<sup>2</sup> has also covered the same point in his diagram "Abb 5."

If we replace  $S_1$  with  $S_0$ , the other unisexual component of *N. tetrasperma*, then two lines of ascocarps are formed. The first are hybrids through crossing 3C and  $S_0$ , the others formed several weeks later are purely 3C through selfing. This illustrates again how a change in nutritive conditions by the presence of another mycelium may increase the self fertility of the hermaphroditic race.

Brief reference to the work of the Moreaus,<sup>3</sup> on the cytology of species of *Neurospora* was made in the paper cited. The questions at issue are rather important as bearing on the old controversy of nuclear behavior in the Ascomycetes. It may not be out of place to show by diagram how the evidence which these authors have furnished really proves beyond question that there must be two nuclear fusions in the life cycle of species of *Neurospora*. The Moreaus state that the cells of the ascogonium of *Neurospora* are at first multinucleate but later on show only a single nucleus each. This condition is pictured in the lower part of the diagram (Fig. 2). Ascogenous hyphae grow out from a uninucleate ascogenous cell. Each cell of the ascogenous hyphae has a single nucleus so that the crozier arises from a stalk cell with only one nucleus.

<sup>2</sup> Kniep, H. Vererbungserscheinungen bei Pilzen. *Bibliographia Genetica* 5: 371-476.

<sup>3</sup> Moreau, M. & Mme. Fernand. Le développement du périthèce chez quelques Ascomycètes. *Rev. Gén. Bot.* 42: 65-98. 1930.

Conjugate division in the crosier having occurred, the two non-sister nuclei fuse. According to their story the ascus nucleus Z must be merely diploid.

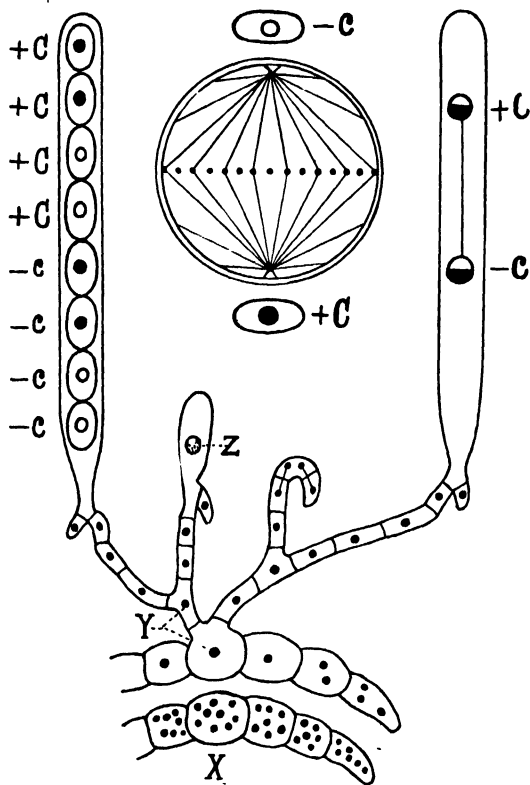


FIG. 2. Diagram to show how the primary nucleus Z of an ascus must be tetraploid if the cytological picture presented by the Moreaus<sup>3</sup> is correct. The lower part of the diagram from X to Z is adapted from their figures. The upper part shows what happens when a conidial race of one sex is mated with a non-conidial race of the opposite sex. Since the nucleus Z must contain the factors +C and -C the nuclei Y must be diploid through some previous nuclear fusion.

Above in the figure is diagramed a plate culture in which two strains of *Neurospora sitophila* of opposite sex are opposed. The mycelium of one race bears conidia (+C), that of the opposite sex is non-conidial (-c). When one isolates the eight spores from an ascus he finds that four of them carry the +C factors and the other four are non-conidial (-c). In some way the

nucleus Z must have received the inheritance carried by each of the two original ascospores with which the culture was inoculated. Since the two nuclei that fused to make Z were derived from a single stalk cell nucleus that goes back to Y for its inheritance, then all of the nuclei of the ascogenous hyphae and the single nucleus of the ascogenous cell must be diploid. If the cytological picture is as claimed by the Moreaus, then there must have been somewhere a nuclear fusion of haploid nuclei, followed by a fusion of diploid nuclei in the ascus as claimed by Harper.

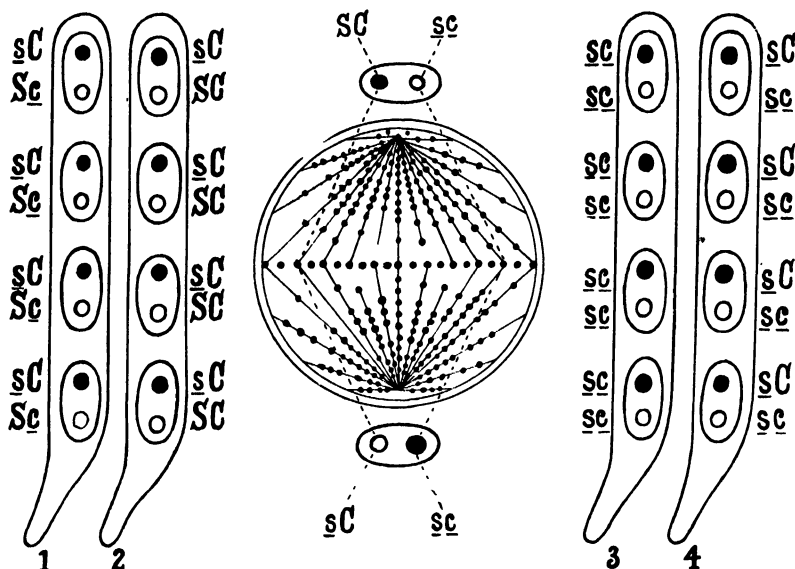
Suppose now some student of the Claussen school should present another cytological paper on *Neurospora* and claim that the several nuclei in the ascogenous cell do not all disappear but one, and claim, instead, that each cell has two nuclei of opposite sex as Claussen stated for *Pyronema*. Would the genetic evidence for a double nuclear fusion then be discredited? No one knows just what happens at the origin of a perithecium. Assume first that only a single pair of nuclei of opposite sex are involved. The diagram shown in figure 3 is constructed to bring out what happens if two hermaphroditic races are grown opposite each other in a culture. As before, the nuclei of opposite sex are indicated in black and white, and the conidial factors by C and c. A third character, the presence or absence of sclerotia, is indicated by S and s respectively. Any other clear cut character may be substituted if necessary.

If only the two nuclei SC and sc from the spore above in the diagram are involved (self fertilization) then all of the asci in that perithecium must be like ascus no. 1. If a hybrid perithecium from the cross  $SC \times sC$  results, then the asci should be like no. 2. In the perithecium  $sc \times sc$  the asci must all be homozygous and like no. 3. With self fertilization involving sC and sc from the spore below in the diagram the asci are like no. 4. Barring minor changes in the ascus pictures due to peculiarities of segregations and distribution of the nuclei before spore formation in each case, all of the asci in any particular perithecium must be alike.

Many different pairs of nuclei Claussen<sup>4</sup> says are involved in the formation of the ascocarp of *Pyronema*. Suppose this were found to be true for these hermaphroditic races of *Neurospora*.

<sup>4</sup> Claussen, P. Zur Entwicklungsgeschichte der Ascomyceten *Pyronema confluens*. Zeits. Bot. 4: 1-64. 1913.

It is clear without further explanation that then we should find all four kinds of asci within the same perithecium. But suppose that the Harper<sup>5</sup> theory of a double nuclear fusion is also operating. It is evident that one might find occasionally a perithecium in which some one ascus would contain all of the inheritance carried by all four nuclei, SC and sc of one sex and sC and sc of the opposite sex. This phase of the work will be studied as time



### Hybridizing two hermaphroditic races.

FIG. 3. Matings of two hermaphroditic races of *Neurospora*. See text for further explanation.

permits. In the meantime we must expect several contradictory stories of nuclear behavior, based wholly on cytological studies.

If perithecia mature because of the stimulus derived from diffusible hormones rather than from sexual reproduction, or a union of nuclei of opposite sex due to anastomosing hyphae, as recently claimed by Moreau and Moruzi<sup>6</sup> we still would have to account

<sup>5</sup> Harper, R. A. Sexual reproduction in *Pyronema confluens* and the morphology of the ascocarp. *Ann. Bot.* 14: 321-400. 1900.

<sup>6</sup> Recherches experimentales sur la formation des périthèces chez les "Neurospora." *Compt. Rend. Acad. Sci. Paris.* 192: 1475-1478. June 8, 1931.

for the mendelian inheritance of morphological characters exhibited in our breeding experiments. Although the gene continues to shrink more and more in size under the scrutiny of modern geneticists, it would be rather revolutionary to think of hormones which can exist outside of the organism and which can wander several centimeters away from their parent chromosome as being wholly responsible for mendelian phenomena.

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#### NOTE

The results of experiments similar to those described by Moreau and Moruzi, carried out by the writer since the above paper was sent to press, do not confirm their claims. Some fifty U-tube cultures in which strains of opposite sex of *Neurospora sitophila* were grown in opposite arms of the tubes as described by these authors have been observed for periods up to four months in length. In no case have perithecia been formed at the surface of the agar in either arm of a tube. Perithecia are matured, however, in every culture just as soon as, due to the drying out of the agar, air pockets move down the arms of the tube so that the two mycelia can come together in the presence of air. Only under such conditions are perithecia formed in these tubes. A more detailed account of these experiments is being published elsewhere.

# TAXONOMIC STUDIES IN THE FAMILY PYTHIACEAE

## II. PYTHIUM<sup>1, 2</sup>

C. P. SIDERIS

(WITH 21 TEXT FIGURES)

### INTRODUCTION

Butler's (4) studies comprised in his paper "An Account of the Genus *Pythium* and Some Chytridiaceae" constitute the best and most exhaustive document we have on the morphology and taxonomic position of this group of organisms. The relationship of the genus *Pythium* to *Nematosporangium* on the one hand, and to *Phytophthora* on the other, has been discussed in a previous paper (11). The discussion contained herewith deals with (1) certain improvements on the classification of members of this genus, (2) the description of new species, and (3) the relationship existing between different species.

### THE GENUS PYTHIUM

The genus *Pythium* as presented in the following pages comprises the group of organisms heretofore belonging, according to Fischer's (5) classification, to the subgenus *Sphaerosporangium*. Besides the organisms originally placed by Fischer in the subgenus *Sphaerosporangium*, there are others that had been described later and either placed by Butler or others likewise in the same subgenus. The total list is a rather long one.

With the adoption of the genus *Nematosporangium*, the subgenus *Sphaerosporangium* is automatically dropped as it is the only subgenus left in the genus *Pythium*. The further grouping of

<sup>1</sup> The species of *Pythium* included in these studies are only those isolated by the writer and Mr. G. E. Paxton from diseased pineapple roots and a few others sent by Dr. W. D. Valleau.

<sup>2</sup> Published with the approval of the Director as Technical Paper No. 20 of the Experiment Station of the Association of Hawaiian Pineapple Canners, University of Hawaii.

organisms with many similarities and dissimilarities in this genus is taken care of by the introduction of sections and subsections according to the importance of the characters under consideration.

Fischer established for this purpose the sections *Orthosporangium* and *Metasporangium*, the former including all those organisms reproducing asexually by means of zoöspores and the latter those by means of conidia. Other characters such as the plerotic as opposed to the aplerotic and the smooth as opposed to the spiny oöspores have been given a secondary position in the taxonomy of species. The shape of the antheridia appears to have escaped the attention of Fischer and the other investigators.

### REPRODUCTION

The various members of *Pythium* reproduce in five distinct ways: (1) by hyphae, (2) by gemmae, (3) by conidia, (4) by zoöspores, and (5) by oöspores.

The various methods may be grouped in three categories as follows:

1. Somatic reproduction, including (1) and (2).
2. Asexual reproduction, including (3) and (4).
3. Sexual reproduction, including (5).

Some organisms reproduce by one or two methods and others by more than two: *P. polycladon*, for example, reproduces by four and possibly, by all five methods.

### SOMATIC REPRODUCTIVE ORGANS

#### MYCELIUM

The mycelium of species of the genus *Pythium* varies in many of its features. It may be aerial or submerged, this being conditioned by the chemical composition of the substratum, sugars or starches having been observed to favor aerial development. Individual hyphae may or may not be septate depending mostly on their age and to a certain extent on the nutrient content of the substratum. Hyphae differ by their thickness, branching, consistency of their protoplasmic contents (that is, whether coarse granular, emulsoid-opalescent or emulsoid-hyaline), regularity or



irregularity, production of allantoid and subspherical bodies, etc. Colonies are represented by various morphological types in the different species such as the plain-radiate (FIG. 1, *a*), pulvinate-radiate (FIG. 1, *b*) and rosette (FIG. 2, *c*). According to Butler (4) the size and thickness of the hyphae of *Pythium* do not approach those of either the Saprolegniaceae or the Peronosporaceae. The allantoid or subspherical bodies common on the hyphae of such species as *P. diamceson*, *P. allantocladon*, *P. eulhyhyphon* and *P. ascophallon* represent reservoirs of protoplasmic material and serve for the vegetative propagation of these organisms.

#### GEMMAE

These structures, represented by extrusions of protoplasm through diametrical breaks produced near the tips of hyphae, have been observed only in *P. polycladon* (FIG. 5, *h*). \* They are not like those formed in *P. rostratum* as illustrated by Butler. They are produced only under slightly adverse conditions, that is, when the organism is grown in culture media not suitable for the production of conidia or zoösporangia. They germinate giving rise to many hyphae simultaneously.

#### ASEXUAL REPRODUCTIVE ORGANS

The organs of asexual reproduction are as follows: (1) the prosporangium or sporangium, (2) the zoösporangium or vesicle, and (3) the conidium.

The prosporangium is the reservoir of protoplasmic matter destined for the production of zoöspores. It varies appreciably in form and size in the different species, being spherical, subspherical, pyriform or lemon-shaped and measuring between 15 and 50  $\mu$  in diameter. It may be terminal or intercalary; in the former case, it is separated from the supporting hypha by a single septum and in the latter case by two septa, one on either side. The production of prosporangia may be rapid or slow according to the behavior of the species producing them.

The germination of a "prosporangium" may give rise either to a vegetative hypha or to a vesicle (zoösporangium) into which are discharged the protoplasmic contents which gradually become

differentiated into zoöspores. The prosporangium in the first case is known as a conidium.

A characteristic feature of a prosporangium is its exit tube. This collar forms at the time of maturity, when the prosporangium gives rise to the zoösporangium, the former discharging its protoplasmic contents into the latter organ. The emission collar varies in length in the different species and may be produced terminally or laterally.

The zoösporangium is the organ wherein the differentiation of the protoplasmic matter, discharged by the prosporangium, takes place. The protoplasm after entering the vesicle undergoes very rapid changes which in 10 to 15 minutes give rise to many reniform biciliate zoöspores. The life of the zoösporangium *per se*, or vesicle, is extremely short. Its wall is a continuation of the ectoplast or inner membrane of the prosporangium. It lasts as long as is required for the differentiation and development of zoöspores, by whose movements it is disrupted. The zoösporangium varies in size in the different species measuring between  $15\ \mu$  and  $50\ \mu$  or more in diameter.

The zoöspores are reniform and biciliate, the cilia arising from the hilum in all the different species studies. They measure between  $8$  and  $12\ \mu$  in diameter at rest. They germinate usually with one germ tube, though occasionally two or more are formed. Their period of motility may last from 5 to 60 minutes and possibly longer depending on environmental conditions.

The conidium is morphologically identical with the prosporangium, except for the type of germination. The conidia of all species of *Pythium* studied are pseudoconidia, that is, they never fall off their supporting hyphae but germinate *in situ*. They may occur in great or moderate numbers or not at all.

#### SEXUAL REPRODUCTIVE ORGANS

The organs of sexual reproduction, namely, the oogonium and antheridium, vary morphologically in the different species.

The antheridium may vary in shape, size, and position in its relation to the oogonium. The shape of most antheridia is clavate, some are more or less cylindrical and others ascomorphic (bag-like). Their length as well as diameter may vary in different

species. Their position in respect to the oögonium may be hypogynous or epigynous. They may be produced from the oögonial hypha or from a different one and occasionally two or three may be borne on the same hypha. The length of the supporting hypha of antheridia, especially of those produced on the oögonial hypha, may be very short or appreciably long.

The oögonia of *Pythium* are spherical to subspherical and all are smooth with the exception of those of *P. megalacanthum* and *P. Artotrogus* which are spiny. They vary considerably in size, measuring between 10 and 70  $\mu$  in diameter. They may be terminal, intercalary (mostly), or lateral. In culture media they are intra- or extra-matrical and in the tissues of hosts intra- or extra-cellular. Their development, maturity and fertilization may be completed in two to ten days in the majority of species. The protoplasmic contents of unfertilized oögonia have a granular appearance and are distributed uniformly throughout the entire organ. Those of fertilized oögonia, however, lose their original colloidal state and concentrate as much as possible towards one side or the center.

The oöspores of *Pythium* are mostly spherical. Those of certain species fill the oögonium (plerotic) and those of others do not fill it (aplerotic). They may be either smooth or spiny. The production of spines and other such appendages seems to be associated with shrinking and distension phenomena in the oögonial membrane of aplerotic oöspores (see FIG. 18). The oöspores, measuring between 8 and 60  $\mu$  in diameter, may contain one large globule of fat or occasionally two or more smaller ones. The thickness of their wall varies between 0.5 and 2.0  $\mu$ . They may germinate in a few days, weeks or months, giving rise either to a vegetative hypha or to a zoösporangium. They are produced in culture media intra- and extra-matrically and in the tissues of hosts intra- and extra-cellularly.

#### CERTAIN TAXONOMIC CONSIDERATIONS IN PYTHIUM

When Pringsheim (9) assigned the generic name *Pythium* to the group of organisms under consideration it was doubtless on account of the morphology of either their emptied prosperangium or the type of injury caused to the roots of plant seedlings. The

emptied prosporangia of *Pythium* (those that have produced zoösporangia) resemble in shape a jug, the equivalent Greek word of which is *pithos* and the diminutive *pithion*. The type of root injury caused to plant seedlings by various members of the genus *Pythium* is a rot, the equivalent Greek word of which is *pythos*, from the verb to cause rot. Therefore, only those members of pythiaceous organisms possessing a pithioid prosporangium should be assigned the generic name of *Pythium*. By applying this definition those species belonging to the two closely related genera, namely, *Nematosporangium* and *Phytophthora* are automatically excluded. Species of *Nematosporangium* never produce a pithioid prosporangium, and species of *Phytophthora* never produce a neck or exit tube on their prosporangia to be classed as pithioid.

The production of plasmatoögoes in the tissues of hosts is a constant feature associated with all the different species of *Nematosporangium*. Similar structures have never been observed to be produced intracellularly by either *Pythium* or *Phytophthora*.

The relatively rapid production of oöspores in the tissues of hosts is a feature more or less constant with all or most species of *Nematosporangium* and *Pythium*, but not with *Phytophthora*.

*Pythium* is divided according to the type of development of its prosporangia. The "prosporangia" of *Pythium* as well as those of *Phytophthora*, may act either as true conidia or as zoösporangia. Fischer (5) created the section *Orthosporangium* to take care of those organisms reproducing by means of zoöspores, and *Metasporangium*, for those reproducing by means of conidia. According to this classification many closely related organisms are placed in different sections. For example, certain varieties of *P. Debaryanum* have been observed to reproduce by means of both zoöspores and conidia and others by means of conidia alone. Certain varieties of *P. irregulare* and *P. megalacanthum* behave in the same way. It is unreasonable to classify in two distinct sections varieties of the same species.

It appears that changes in the asexual reproduction which favor the development of either zoöspores or conidia are not of fundamental importance, as they are impressed mostly by environmental conditions and may become fixed in certain varieties or remain in a transitory state. Therefore, the subdivision of *Pythium* into the

sections *Orthosporangium* and *Metasporangium* is neither of fundamental importance nor of great reliability for the grouping of organisms. Separation of species on this basis, however, is justified as will be indicated later.

The writer has observed that morphological differences in the sexual organs and especially the antheridia and oöspores are of greater fundamental importance and of greater stability than those in the asexually reproducing organs. For example, the ascomorphic as opposed to the clavate type of antheridium constitutes a very stable and reliable character for the differentiation of species and for their classification as elementary or advanced forms. The ascomorphic type is associated with more elementary forms of organisms than the clavate type. The writer proposes, therefore, that *Pythium* be subdivided into the subgenera *Platyphalla* and *Stenophalla*, the former including those species with ascomorphic antheridia and the latter those with clavate antheridia. The oöspores of the different species of *Pythium* are either of the plerotic or the aplerotic type, their morphology in this respect being of fundamental importance. It is a constant feature, not altered or modified in any way by environmental conditions. The sections *Plerospora* and *Aplerospora* are proposed, the former to include those species with plerotic and the latter, those with aplerotic oöspores. There are also a number of species whose sexual reproduction is unknown. These are placed on the basis of certain morphological characters next to the species of the sections whose sexual reproduction is very rare.

Besides the main subdivisions, there are subdivisions of a secondary and tertiary type in connection with the proper classification of these organisms. The organisms of *Aplerospora* may have both smooth and spiny oöspores. A subdivision between these morphologically different subgroups is essential. The creation of the subsections *Leiospora*, *Polymorphospora* and *Acanthospora*, the first including those with smooth oöspores, the second those with both smooth and spiny, and the third, those with only spiny oöspores, will segregate three groups of organisms the oöspores of which, although all aplerotic, are different in appearance.

To return to the taxonomic importance of the development of "prosporangia" into conidia or into zoösporangia, these characters, as mentioned before, are variable and unreliable to use in a major subdivision. They can be used, however, with a fair degree of safety as a character of a minor subdivision. Organisms reproducing by means of both zoöspores and conidia, and by conidia alone, may be designated as orthosporic and metasporic, respectively.

The order followed for the placement of the various species in an ascending or descending scale is that shown by the morphological simplicity or complexity of the oöspores. Those species whose oöspores are aplerotic have been considered the simplest forms. These are followed by those species with plerotic oöspores. Such an order seems to be rational as well as simple and although it may not follow the order of phylogenetic relationship among the different species, nevertheless it is convenient, for which reason it is presented here.

The rosette type of colony as opposed to the pulvinate and other similar types is a very distinctive feature of different species of *Pythium*.

The writer's definition of *Pythium* "that only organisms with pithioid prosporangia should be placed in the genus *Pythium*" although perfect in so far as it goes is too general and, therefore, requires some modification to make it more elastic in the case of those organisms whose prosporangial or rather zoösporangial stage has never been observed. There are quite a number of other characters common to all species of *Pythium* besides the prosporangial or zoösporangial stage, such as morphology of the hyphae. It is possible that in cases of this type where many transitional forms are likely to be met with uncertainties will always exist. *P. acanthophoron* described in this paper as new presents such a case. This organism produces oöspores profusely but has never been observed to produce prosporangia or zoösporangia. Its mycelium, however, has the usual *Pythium* type of growth but in addition it has extremely short branches appearing like protrusions that bring it close to the dendroid type of mycelium of *Phytophthora*. There is no other way of classifying such an organism except by taking into consideration the sum total of its morphological characters.

## NUTRITIONAL REQUIREMENTS OF PYTHIUM

*Pythium*, like *Nematosporangium*, grows best on culture media prepared from vegetable tissues. Although there is quite an appreciable variation in the behavior of the different species, most of them reproduce readily in a relatively wide variety of culture media. There are some that reproduce extremely rarely, either sexually or asexually, both in culture media and in tissues of hosts.

There is a natural tendency for the various species to reproduce mostly in one way, that is, either asexually or sexually. Those species that reproduce readily by both methods are very few. It is difficult if not impossible, to alter such behavior in some of these organisms with the use of culture media. Culture media for *Pythium* cultures should be considered always from the point of view of their nutritional value. They should be rich in amino acids, proteins, sugars, fats and all such constituents essential for the production of protoplasmic matter.

## CULTURE MEDIA

The media best suited for the growth of species of *Nematosporangium* were found also suitable for the different species of *Pythium*. *Carica Papaya* juice, and the seeds of *Cucumis Citrullus*, *C. Melo* and *Cannabis sativa* or such combinations as *Cucumis Melo* seeds, *Cannabis sativa* seeds and dextrose, described in my previous paper (11), were found to give the best results. Culture media prepared through the activation of bacterial ferments or vitiated in some way by microbiological waste products are not as suitable for the successful growth and reproduction of pythiaceous organisms as those referred to above.

## TECHNIQUE

The technique described under *Nematosporangium* (11) was, likewise, followed in these studies. The organisms were grown mostly on *Carica Papaya* agar, each one in five separate Petri dish cultures and its growth, sporulation and other types of behavior studied daily.

KEY TO THE SPECIES OF PYTHIUM <sup>2</sup>

- A.* Antheridia broad, ascomorphic, undergoing slight morphological changes before and after fertilization: PLATYPHALLA.
- B.* Oöspores aplerotic; section: *Aplerospora*.
- C.* Oöspores smooth; subsection: *Leiospora*.
- D.* Asexual reproduction metasporic; conidia very rare and small, oöspores produced in culture media and tissues of hosts.
- E.* Hyphae mostly regular, laterals with many allantoid bodies; colony slightly rosette on solid culture media; aerial mycelium either lacking or poorly developed; oöspores in suitable culture media: *P. allantoclados* (1)
- EE.* Hyphae mostly regular, laterals very rarely with allantoid bodies; colony strongly rosette on solid culture media; aerial mycelium strongly developed; gemmae occasionally present; oöspores many in suitable culture media: *P. ascophallon* (2)
- DD.* Asexual reproduction orthosporic and metasporic; prosperangia spherical to subspherical, terminal and intercalary, exit tube lateral, conidia same size as prosperangia.
- E.* Oöspores produced readily in suitable culture media and tissues of hosts; produced mostly at the expense of asexual organs and vice versa; hyphae mostly regular, laterals without allantoid bodies; colony mostly rosette on solid culture media; aerial mycelium moderately to well developed: *P. complectens* B. (3)
- EE.* Oöspores produced occasionally in the tissues of hosts, never observed in culture media.

<sup>2</sup> This key is more descriptive than necessary for the purpose of pointing out most of the outstanding morphological and cultural characters of each organism.



- F.* Colony when young, strongly rosette, when old covered with a thick layer of aerial mycelium; gemmae present; hyphae regular, laterals irregular, branching dichotomously, in zigzag formations, without allantoid bodies; exit tube of prosperangium terminal: *P. polycladon* (4)
- FF.* Colony when young, strongly rosette, aerial mycelium either lacking or poorly developed; oöspores and antheridia not observed; germination tube of prosperangium lateral; gemmae not present: *P. chamaihyphon* (5)
- FFF.* Colony when young radiate, aerial mycelium mostly lacking; exit tube of prosperangium terminal; oöspores observed only in the tissues of hosts; hyphae very regular, straight, laterals of a smaller diameter with few large allantoid bodies: *P. euthyhyphon* (6)
- EEE.* Oöspores never observed in culture media or tissues of hosts. Colony rosette, slow growing; aerial mycelium well developed in old cultures; hyphae regular, branching laterally: *P. intermedium* (7)
- CC.* Oöspores spiny; subsection: *Acanthospora*.
- D.* Asexual reproduction unknown; hyphae irregular, dendroid, aerial mycelium poorly developed; antheridia epigynous; oöspores mostly terminal, small with short spines: *P. acanthophoron* (8)
- DD.* Asexual reproduction mostly metasporeic and rarely orthosporeic; prosperangia mostly intercalary developing into conidia;

hyphae irregular; colony faintly developed with small superficial whitish specks; antheridia epigynous; oöspores large, terminal, with long spines:

*P. megalacanthum* (9)

BB. Oöspores plerotic; section: *Plerospora*.

(No species have been found belonging in this section.)

AA. Antheridia more or less narrow, clavate, not undergoing appreciable morphological changes before or after fertilization:

STENOPIHALLA.

B. Oöspores aplerotic; section: *Aplerospora*.

C. Oöspores smooth; subsection: *Leiospora*.

D. Asexual reproduction orthosporic and metasporic; prosorangia spherical to subspherical, small, orthosporic in certain varieties and metasporic in others, exit tube lateral, conidia same as prosorangia; oöspores produced readily and numerous in culture media and tissues of hosts; antheridia mostly one in relation to a single oögonium; hyphae regular, laterals without allantoid bodies; colony pulvinate to arachnoid; aerial mycelium well developed:

*P. Debaryanum* (10) √

DD. Asexual reproduction never observed; oöspores extremely few in culture media, terminal, intercalary and catenulate; antheridia 1 to 2 in relation to a single oögonium; hyphae regular, laterals with a prominent constriction at base; colony radiate; aerial mycelium poorly developed:

*P. araiosporon* (11)

DDD. Asexual reproduction metasporic; conidia mostly large spherical to subspherical; oöspores rare produced only in the tissues of hosts and old cultures; antheridia mostly one in relation to a single oögonium; hyphae relatively regular, laterals terminating in irregular bodies; colony arachnoid; aerial mycelium well developed:

*P. splendens* (12)

- E.* Conidia teratomorphic and also spherical to subspherical; oöspores produced in the tissues of hosts; antheridia not observed; hyphae broad; colony arachnoid to pulvinate and slightly zonate; aerial mycelium well developed: *P. teratosporon* (13)
- CC.* Oöspores smooth or with one to many spines; subsection: *Polymorphospora.*
- D.* Asexual reproduction mostly metasporic and occasionally orthosporic; prosperangia and conidia terminal and intercalary, in certain varieties orthosporic and others metasporic:
- E.* Antheridia mostly one in relation to a single oogonium; oöspores terminal and intercalary; conidia relatively few; hyphae regular, laterals without allantoid bodies; colony arachnoid to pulvinate; aerial mycelium moderately to well developed: *P. irregulare* (14)
- EE.* Antheridia mostly two in relation to a single oogonium, clavate, and supported on relatively long sickle shaped filaments; oöspores terminal and intercalary; conidia numerous; aerial mycelium strongly developed: *P. polymorphon* (15)
- CCC.* Oöspores acanthophoric (spiny); oogonia smooth; subsection: *Acanthospora.*
- D.* Acanthae (spines) blunt and short; asexual reproduction mostly metasporic and occasionally orthosporic; prosperangia and conidia terminal and intercalary; hyphae regular; aerial mycelium moderately developed; antheridia mostly one in relation to a single oogonium; oöspores terminal and intercalary: *P. mamillatum* (16)
- DD.* Acanthae long and sharp; asexual reproduction mostly metasporic; prosperangia mostly intercalary; antheridia mostly one

in relation to a single oögonium, hypogynous mostly and occasionally epigynous; oöspores terminal and intercalary; hyphae regular, laterals with allantoid bodies occasionally; aerial mycelium strongly developed; colony pulvinate to arachnoid:

*P. Artotrogus* (17)

BB. Oöspores plerotic and smooth; section: *Plerospora*.

C. Asexual reproduction orthosporic and metasporic; prosperangia intracellular and zoösporangia extracellular; conidia extracellular; oöspores in suitable culture media and tissues of hosts; antheridia mostly one in relation to an oögonium; hyphae irregular, laterals with blunt and swollen tips; colony slightly rosette; aerial mycelium moderately developed:

*P. diameson* (18)

CC. Asexual reproduction metasporic; conidia very rare; oöspores numerous, small in culture; antheridia mostly one in relation to an oögonium; hyphae regular, with blunt tips; colony strongly rosette; aerial mycelium either lacking or faintly developed:

*P. plerosporon* (19)

## DESCRIPTION OF SPECIES

### 1. *P. allantocladon* sp. nov. (FIG. 2, A AND 10).

Mycelium extracellular in culture media exhibiting a very weak aerial development; hyphae relatively regular in young cultures, main hyphae 4 to 7  $\mu$  and laterals 2 to 4  $\mu$  in diameter, the latter producing regularly, at their tips, allantoid structures measuring 8 to 12  $\mu$  in diameter, which may either germinate vegetatively or occasionally produce sexual organs; asexual reproduction metasporic; conidia subspherical, terminal and occasionally intercalary, extremely irregular in size, 12 to 25  $\mu$  in diameter, few and seldom produced on the allantoid hyphae; oögonia subspherical, 18 to 24  $\mu$  in diameter; lateral terminal or intercalary and may be produced occasionally on the hyphae arising from allantoid bodies; antheridia clavate to ascomorphic, 10 to 16  $\mu$  in length and 8 to 10  $\mu$  in diameter, surrounding oöspores after fertilization, as crescent shaped bodies; oöspores spherical intra- and extra-matrical, aplerotic, 10 to 20  $\mu$  in diameter, wall 1.2 to 1.8 in thickness, single, produced in 1- to 2-weeks-old cultures.

*Mycelio aërio brevi*; hyphis principibus uniformibus,  $4-7\ \mu$  diam., hyphis lateralibus gracillimis  $2-4\ \mu$ , cum apicibus incrassatis et doliformibus  $8-12\ \mu$ ; regeneratione asexuali metasporica; conidiis (pseudoconidiis) subsphaericis, terminalibus et intercalariis,  $12-25\ \mu$ ; oögoniis sphaericis, terminalibus et intercalariis,  $18-24\ \mu$ ; antheridiis claviformibus vel asciformibus,  $10-16 \times 8-10\ \mu$ ; oösporibus sphaericis, apleroticis  $10-20\ \mu$ .



FIG. 1. Colonies 48 hours old on *Carica Papaya* agar; a, *P. araiosporon*; b, *P. Debaryanum*; c, *P. acanthophoron*; d, *P. diameson*.

It was first obtained together with other pythiaceous organisms from the diseased roots of *Spinacea oleracea* grown on the island of Oahu of the Hawaiian Archipelago. It failed to invade the

root tissues of *Ananas sativus* on inoculation and is considered to be a saprophyte.

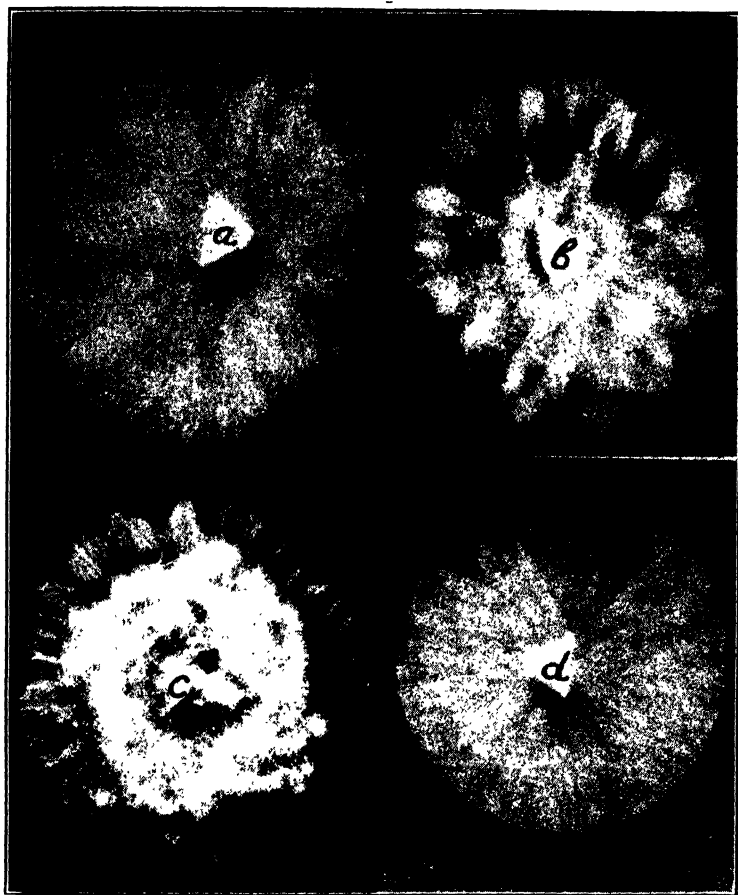


FIG. 2. Colonies 48 hours old on *Carica Papaya* agar: a, *P. allanto-cladon*; b, *P. ascophallon* (rosette); c, *P. polycladon* (rosette); d, *P. euthy-hyphon* (radiate).

2. *P. ascophallon* sp. nov. (FIG. 2, B; FIG. 6, D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub>; FIG. 9).

Mycelium intra- and extra-cellular, in culture media (*Carica Papaya* agar) exhibiting a very good aerial development; hyphae relatively regular,  $6\mu$  in diameter, laterals slightly irregular, 3 to  $4\mu$  in diameter, may under certain conditions produce allantoid structures on submerged as well as aerial hyphae; asexual repro-

duction metaspore; conidia rare and of irregular size, analogous to the allantoid bodies of lateral hyphae; oögonia subspherical, lateral and occasionally intercalary, 16 to 25  $\mu$  in diameter, produced

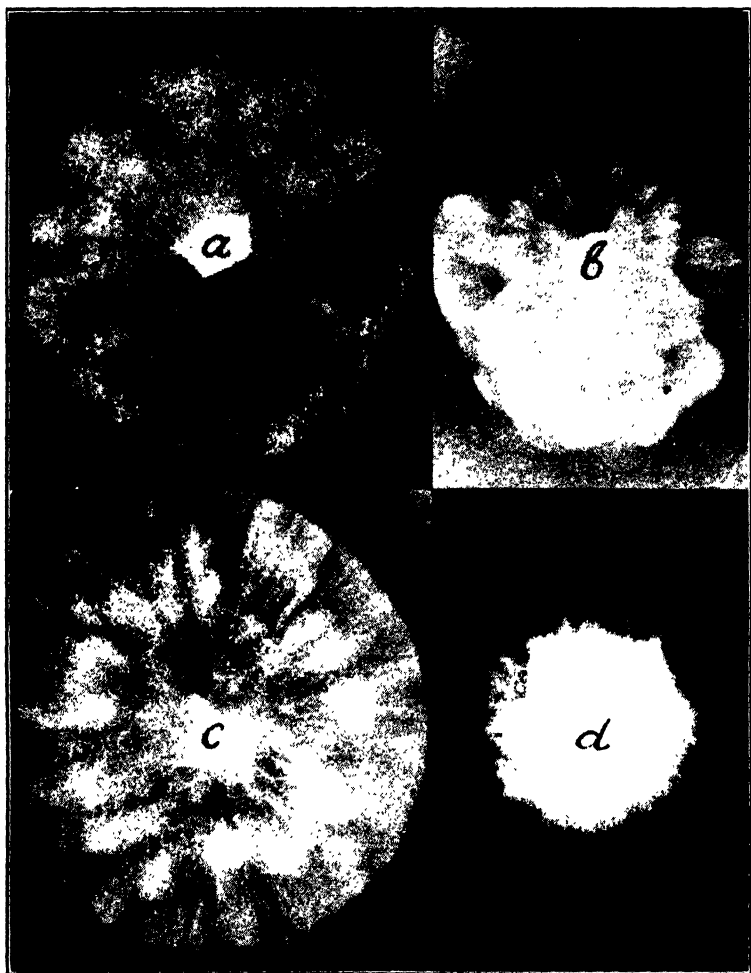


FIG. 3. Colonies 48 hours old on *Carica Papaya* agar: a, *P. mamillatum* (rosette); b, *P. plerosporon* (rosette); c, *P. complectens* (rosette); d, *P. intermedium*.

in groups first and later throughout the entire colony; antheridia ascomorphic before fertilization and may be falcate after fertilization, developing either on the same or on a different hypha from

that of the oogonium, 10 to 15  $\mu$  in length and 10 to 12  $\mu$  in diameter at the thickest point tapering gradually towards delimiting septum, with a fertilization tube located at the center of the apical surface area of the baglike antheridium, one in relation to a single oogonium; antheridium losing its initial shape by gradual collapsing and falling on oogonial wall, as fertilization proceeds and attachment between it and the oogonium becomes firmer (the original tip or fertilization tube of antheridium being the center of attachment stays in position while the peripheral area of baglike structure forms a crescent shaped body around oogonium) (FIG. 6,  $D_1$ ,  $D_2$ ,  $D_3$ ); oöspores spherical, intra- and extra-matrical, aplerotic, single, 12 to 18  $\mu$  in diameter, wall 1.0 to 1.5  $\mu$  in thickness, produced on suitable culture media and in the tissues of hosts.

Mycelio aërio plene maturo; hyphis principibus uniformibus 6  $\mu$ , hyphis lateralibus 3–4  $\mu$ , cum accretionibus allantiformibus intercalaribus et terminalibus; regeneratione asexuale metasporica; conidiis inaequalibus, infrequentibus; oogoniis subsphaericis, lateralibus et intercalaribus, 16–25  $\mu$ ; antheridiis asciformibus, 10–15  $\times$  10–12  $\mu$ ; oösporibus sphaericis, apleroticis, 12–18  $\mu$ .

It was first obtained from the diseased roots of *Spinacea oleracea* grown on the island of Oahu of the Hawaiian Archipelago, and also from the roots of *Ricinus communis* grown on the grounds of the farm of the University of Hawaii. It was found, on inoculation, to be an extremely weak parasite of the roots of *Ananas sativus*.

3. *P. COMPLECTENS* Braun, Jour. Agr. Res. 29: 415. 1924 (FIG. 3, c; 8, E–F).

Mycelium intra- and extra-cellular in culture media exhibiting a weak to moderate aerial development, colony rosette; hyphae relatively regular, hyaline 2 to 5  $\mu$  in diameter with rounded tips forming a strongly parallel silky growth; asexual reproduction orthosporic and metasporic, prosperangia and conidia 16 to 27  $\mu$  in diameter; zoösporangia 15 to 35  $\mu$  in diameter containing 8 to 24 reniform biciliate zoöspores measuring 8  $\mu$  in diameter, at rest; oogonia spherical to subspherical mostly on laterals, 18 to 25  $\mu$  in diameter; antheridia ascomorphic, size variable; oöspores spherical, 12 to 22  $\mu$  in diameter, single, aplerotic, wall 1.2 to 1.8  $\mu$  in thickness.

It was first obtained by Braun from *Coleus* and *Pelargonium* cuttings. The writer obtained it from the diseased roots of *Carica Papaya* grown on the island of Oahu of the Hawaiian Archipelago.



4. *P. polycladon* sp. nov. (FIG. 2, c; FIG. 5, c AND II; FIG. 14).

Mycelium intra- and extra-cellular in culture media exhibiting a profuse aerial development; hyphae regular 2 to 4  $\mu$  in diameter, laterals dichotomously branching at very short intervals; gemmae

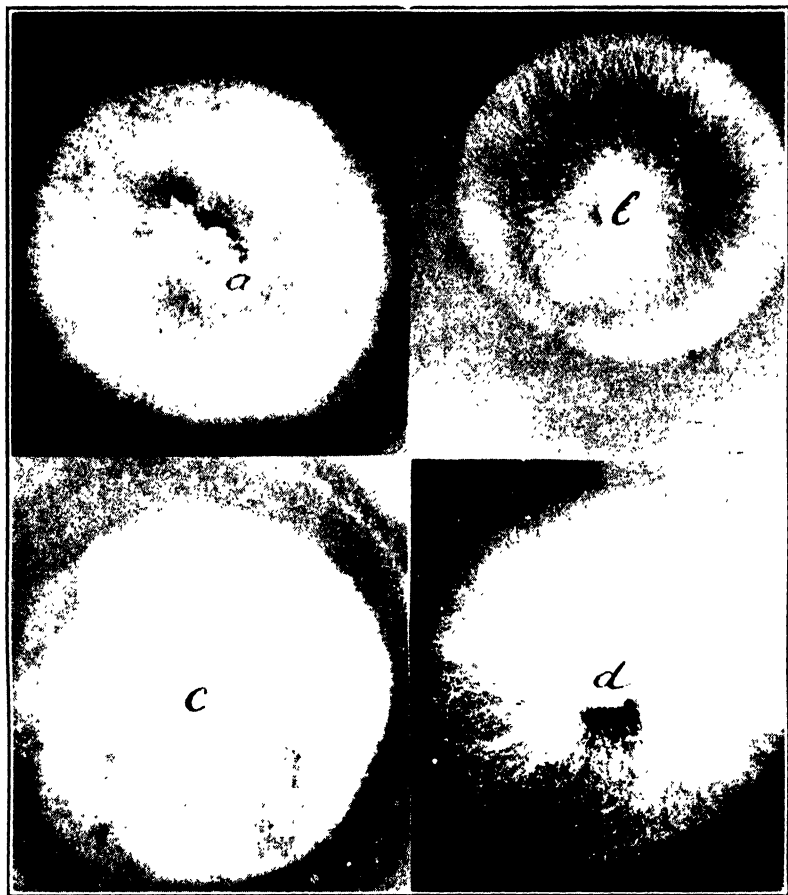


FIG. 4. Colonies on *Carica Papaya* agar: a, *P. irregulare* (48 hours old) (pulvinate); b, *P. polymorphon* (24 hours old) (pulvinate); c, *P. artotrogum* (48 hours old) (arachnoid); d, *P. splendens* (24 hours old) (pulvinate).

often produced in unfavorable culture media, amorphous, germinating with many germ tubes; asexual reproduction orthosporic and metaspore; prosperangia subspherical or lemon-shaped, 18 to 24  $\mu$  in diameter, produced in favorable culture media and on the

surface of infected tissues of hosts; zoösporangia produced under favorable conditions, 24 to 32  $\mu$  in diameter containing 8 to 24 zoöspores, exit tube 7 to 10  $\mu$  long and 4  $\mu$  in diameter; conidia produced on single or occasionally on branched conidiophores, size and shape same as prosperangia; zoöspores reniform, biciliate, remaining motile from 10 to 30 minutes or possibly longer, then rounding up into subspherical bodies, 10  $\mu$  in diameter, which germinate a few hours later by one germ tube; oögonia and oöspores observed only in the tissues of hosts, never in culture media, about 20  $\mu$  in diameter. (The identity of oöspores in the tissues could not be definitely established owing to their rare development, their small number, and also to the optical difficulties encountered in detecting such hyaline structures as antheridia inside the tissues.)

Mycelio aerio plene maturó; hyphis uniformibus 2-4  $\mu$ ; gemmis infrequentibus; regeneratione asexuali orthosporica vel metasporica; prosperangiis subsphaericis vel citronformibus, 18-24  $\mu$ ; zoösporangiiis, 24-32  $\mu$ ; zoösporis reniformibus, 8-24; tubis exitibus, 7-10  $\times$  4  $\mu$ ; conidiis (pseudoconidiis), 18-24  $\mu$ ; conidiophoris simplicibus vel ramosis; regeneratione sexuali infrequente.

It was first obtained from the diseased roots of *Ricinus communis* grown on the grounds of the University of Hawaii farm in Manoa, Oahu, Hawaiian Archipelago. It is a relatively weak parasite of the roots of *Ananas sativus*.

##### 5. *P. chamaihyphon* sp. nov. (FIG. 15, G<sub>1</sub>-G<sub>5</sub>).

Mycelium in culture media (*Carica Papaya*) either exhibiting a very weak aerial development or lacking; hyphae regular 2 to 5  $\mu$  in diameter, laterals dichotomously branching at very short intervals; gemmae never observed; asexual reproduction orthosporic and metasporic, prosperangia subspherical, 15 to 25  $\mu$  in diameter, produced in favorable culture media, developing into zoösporangia readily under favorable conditions, 15 to 30  $\mu$  in diameter, and containing 4 to 24 zoöspores, exit tube 5  $\mu$  in diameter by 5  $\mu$  in length; conidia produced on simple conidiophores, size and shape same as prosperangia; zoöspores reniform, biciliate, remaining motile 10 to 30 minutes or longer, then rounding up into subspherical bodies, about 10  $\mu$  in diameter, which may germinate in a few hours by one germ tube; oögonia, antheridia and oöspores never observed in culture media.

Mycelio aerio typice brevi; hyphis uniformibus, 2-5  $\mu$ ; regeneratione asexuali orthosporica et metasporica; prosperangiis subsphaericis, 15-25  $\mu$ ; zoösporangiiis, 15-30  $\mu$ ; zoösporis reniformibus, 4-24; regeneratione sexuali ignota.

It was first obtained from the diseased roots of *Carica Papaya* grown on the island of Oahu of the Hawaiian Archipelago.

6. *P. euthyhyphon* sp. nov. (FIG. 2, D; FIG. 5, D; FIG. 15).

Mycelium intra- and extra-cellular, in culture media (*Carica Papaya* agar) exhibiting a very weak aerial development; hyphae very regular,  $5\ \mu$  in diameter, laterals about  $3\ \mu$  in diameter with allantoid bodies 10 to  $15\ \mu$  in diameter developing in cultures of 1 to 3 weeks old, and possibly serving as storage organs, germinating under favorable conditions by one or more germ tubes; asexual reproduction orthosporic and metasporic, prosperangia subspherical or lemon-shaped, 16 to  $22\ \mu$  in diameter, developing on the surface of diseased tissues of hosts and in culture media; zoösporangia forming readily from prosperangia when diseased tissues of hosts are placed in water, 22 to  $28\ \mu$  in diameter, containing from 8 to 24 and possibly more zoöspores; exit tube  $3\ \mu$  in length by  $4\ \mu$  in diameter; zoöspores reniform, biciliate, remaining motile from 10 to 30 minutes and possibly a longer or shorter period, then rounding up into subspherical bodies,  $10\ \mu$  in diameter, which may germinate in a few hours; conidia identical in size and shape with prosperangia produced readily on *Cannabis sativa* agar and other culture media, germinating by a single germ tube; oögonia and oöspores, about  $18\ \mu$  in diameter, observed in the tissues of hosts but never in culture media, produced in the former case very rarely. (Their identity can be made out with great difficulty and uncertainty owing to the optical difficulties involved in detecting the antheridia in the tissues. Their size is practically the same as that of conidia and it is possible that they are conidia though conidia are rarely produced intracellularly.)

Mycelio aërio typice brevi; hyphis principibus uniformibus,  $5\ \mu$ , hyphis lateralibus,  $3\ \mu$ , cum apicibus allantiformibus; regeneratione asexuali orthosporica vel metasporica; prosperangiis subsphaericis vel citroniformibus,  $16\text{--}22\ \mu$ ; zoösporangiis,  $16\text{--}28\ \mu$ ; zoösporis reniformibus,  $8\text{--}24$ ; regeneratione sexuali infrequente.

It was first obtained from the diseased roots of pineapple plants grown in the greenhouse. The planting material, shoots or suckers of unknown origin, was sent to the writer by the Agriculture Department of the Experiment Station. It was found upon inoculation to be a weak parasite of the roots of *Ananas sativus*.

7. *P. INTERMEDIUM* deBary, Bot. Zeit. 39: 554. 1881 (FIG. 3, D).

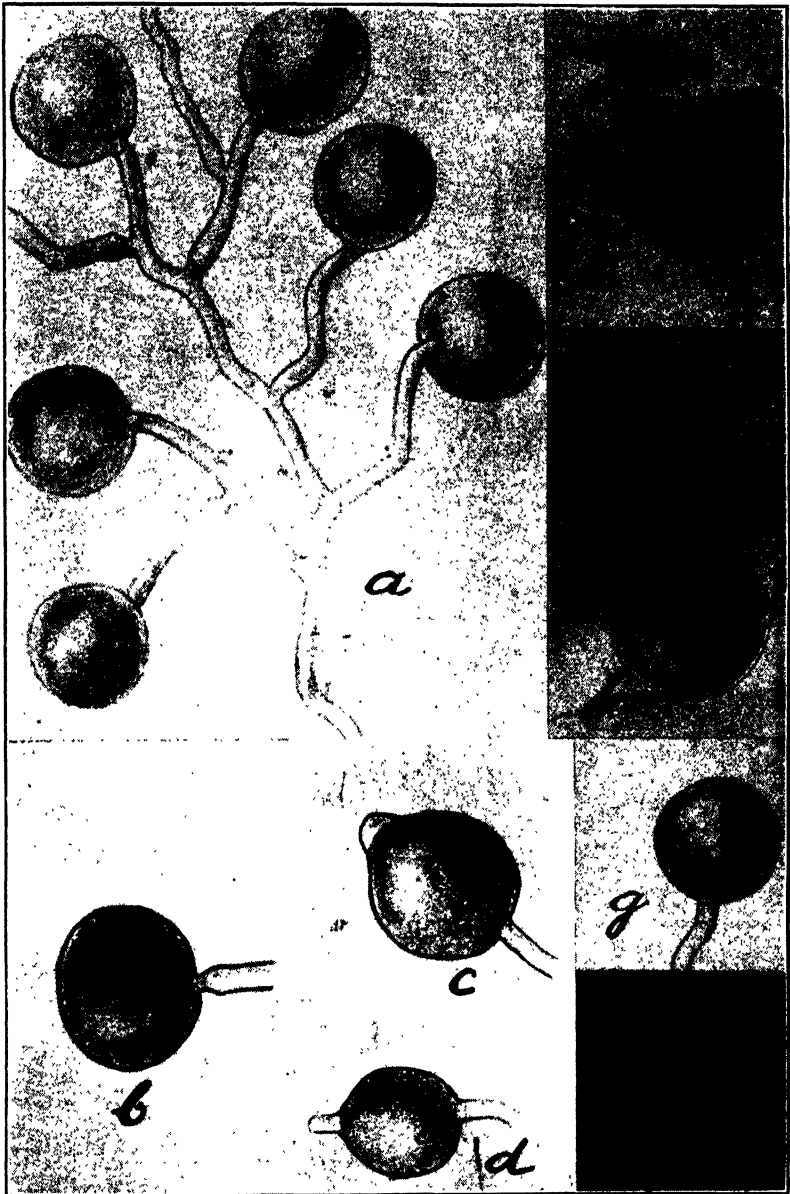


FIG. 5. Conidia or prosperangia and gemmae of *Pythium* spp.: a, *P. splendens* (branched conidiophore); b, *P. Debaryanum* (ellipsoid conidium); c, *P. polycladon* (citroform) (h) gemmae; d, *P. eutryhyphon*; e and f, *P. teratosporon* (teratomorphic conidia); g, *P. polymorphon* (spherical).

8. *P. acanthophoron* sp. nov. (FIG. 1, c; FIG. 6, F; FIG. 19).

Mycelium intra- and extra-cellular, aerial development in culture media either lacking or very weak; hyphae irregular slightly dendroid, 3 to 7  $\mu$  in diameter, laterals very short and irregular; asexual reproduction never observed; oögonia spherical, smooth, 20 to 30  $\mu$  in diameter, produced in great numbers in young as well as old cultures on suitable culture media, many not fertilized and some abortive; antheridia ascomorphic, vermiculate and allantoid borne either on the oögonial hypha or on other laterals, 10 to 20  $\mu$  in length by 4 to 8  $\mu$  in diameter with a slight constriction in the middle, tapering gradually towards delimiting septum; oöspores spherical, echinulate, 15 to 25  $\mu$ , without the spines and with the spines 20 to 32  $\mu$  in diameter, wall about 1.5  $\mu$  in thickness.

Mycelio aerio mediocriter maturo vel ferme nullo in culturis in patellis; hyphis irregularibus, dendriformibus, 3–7  $\mu$ ; regeneratione asexuali ignota; oögoniis sphaericis, levibus, 20–30  $\mu$ ; antheridiis asciformibus, vermiculatis, 10–20  $\times$  4–8  $\mu$ ; oösporibus sphaericis, echinulatis, 20–32  $\mu$ .

It was first obtained from the base of diseased leaves of *Ananas sativus* grown in the district of Paumalu, island of Oahu of the Hawaiian Archipelago. It was found on inoculation to be an extremely weak parasite of the roots of *Ananas sativus*.

9. *P. MEGALACANTHUM* deBary, 1881 (Verh. Senckenb. Ges. 12: 243 und Bot. Zeit. 39: 539, 1881). (FIG. 20–c).

10. *P. DEBARYANUM* Hesse, *Pythium Debaryanum*, ein endophytischer Schmarotzer. 1874. Butler, E. J. (4) (FIG. 1, B, FIG. 5, B; FIG. 11).

Mycelium intra- and extra-cellular, in culture media exhibiting a strong aerial development; hyphae regular, 5 to 10  $\mu$  in diameter, laterals partly irregular, 3 to 6  $\mu$  in diameter; asexual reproduction metaspore; conidia (pseudoconidia) few, spherical to subspherical, 15 to 20  $\mu$  in diameter, germinating readily in water mostly by a single germ tube; oögonia spherical, smooth, mostly terminal, 20 to 25  $\mu$  in diameter, produced in the tissues of hosts and in culture media; antheridia clavate, agchylolaimic and mostly one in relation to a single oögonium, 12 to 16  $\mu$  in length by 8 to 10  $\mu$  in diameter, tapering gradually towards delimiting septum of supporting hypha, borne mostly on oögonial hyphae and occasionally on other hyphae; oöspores spherical, 16 to 22  $\mu$  in diameter, wall 1.5 in thickness, produced in appreciable numbers in the tissues of hosts and culture media.

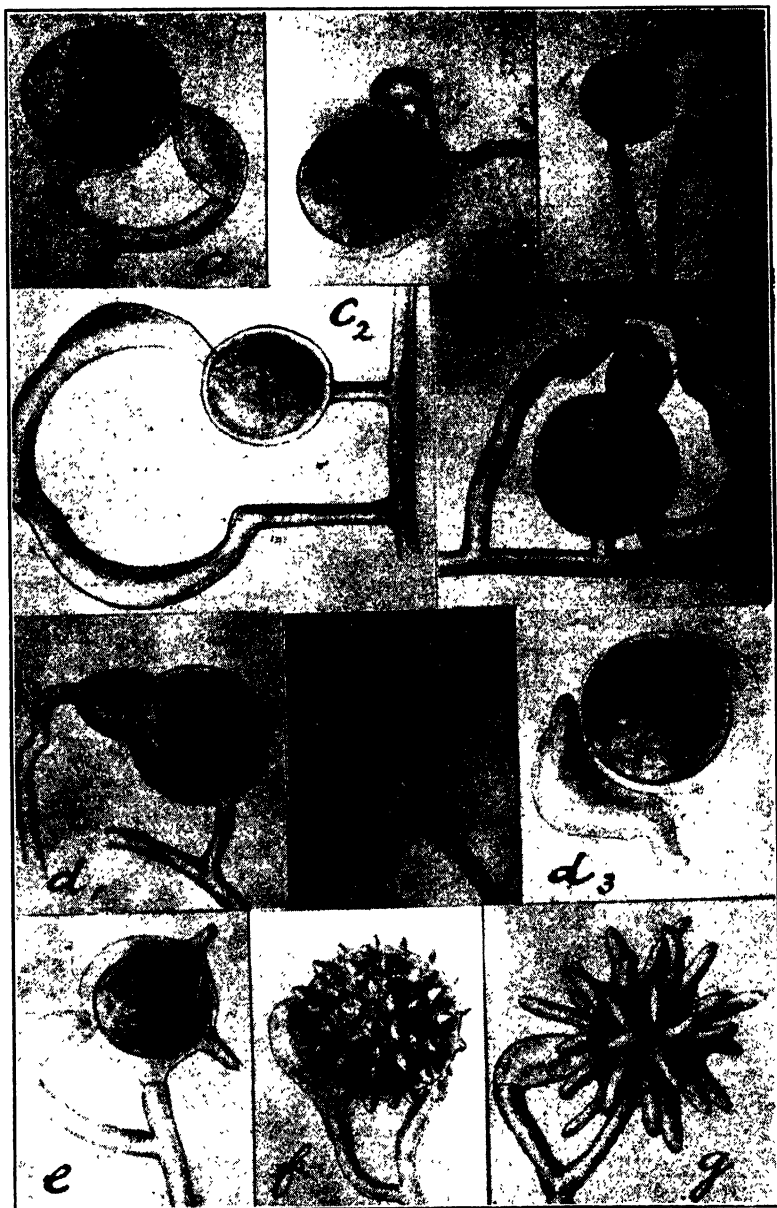


FIG. 6. Sexual organs of *Pythium* spp.: a, *P. diameson* (plerotic oöspore, clavate antheridium); b, *P. Debaryanum* (aplerotic oöspore, clavate antheridium); c<sub>1</sub>, c<sub>2</sub>, c<sub>3</sub>, *P. polymorphon* (polymorphic oöspore, clavate antheridium); d<sub>1</sub>, d<sub>2</sub>, d<sub>3</sub>, *P. ascophallon* (aplerotic oöspore, ascomorphic antheridium); e, *P. irregulare* (polymorphic oöspore, clavate antheridium); f, *P. acanthophoron* (acanthophoric oöspore, ascomorphic antheridium); g, *P. Artotrogus* (acanthophoric oöspore, clavate antheridium).

It was obtained from the diseased roots of *Ananas sativus* grown on the islands of Oahu and Maui of the Hawaiian Archipelago. It is a moderate to a weak parasite of the roots of *Ananas sativus*, *Canavalia ensiformis*, *Ipomoea Batatas*, *Solanum tuberosum*, *Vicia faba*, *Zea Mays*, *Vigna sinensis* and *Cajanus indicus*.

11. **P. araiosporon** sp. nov. (FIG. 1, A; FIG. 8).

Mycelium on culture media producing a weak to moderate aerial development; colony radiate; hyphae mostly regular, 6 to 12  $\mu$  (average 8  $\mu$ ) in diameter, laterals 3 to 5  $\mu$  with a very prominent constriction at their base; asexual reproduction never observed; oögonia spherical to subspherical, mostly intercalary and occasionally catenulate, 30  $\mu$  in diameter, few on highly suitable substrata (*Carica Papaya*, etc.); antheridia clavate, agchylolaimic, 10  $\mu$  in length along axis from apex to basal septum and 5  $\mu$  in diameter at the distal expanded portion, produced mostly on oögonial hyphae; oöspores spherical, aplerotic, 16 to 22  $\mu$  in diameter, mostly intercalary and catenulate, wall 2  $\mu$  in thickness, produced in very few numbers in highly suitable substrata.

Mycelio aerio typice brevi; hyphis uniformibus, 6–12  $\mu$ ; ramis in basis constrictis; regeneratione asexuali ignota; oögoniis sphaericis, 30  $\mu$ ; antheridiis clavatis cum collis curvatis, 10  $\times$  5  $\mu$ ; oösporis sphaericis, apleroticis, intercalaribus et catenulatis.

It was isolated by the author from the diseased roots of *Carica Papaya* grown in Manoa Valley, island of Oahu, Hawaiian Archipelago. A culture of this same organism was also sent to the writer by Dr. W. D. Valleau of the University of Kentucky, from the diseased roots of tobacco.

12. **P. splendens** var. **hawaiiianum** var. nov. (FIG. 4, D; FIG. 5, A; FIG. 12). (Braun 2)

Mycelium intra- and extra-cellular, in culture media (*Carica Papaya* agar) exhibiting a strong aerial development; hyphae regular, laterals irregular, 5 to 8  $\mu$  in diameter; asexual reproduction metaspore; conidia (pseudoconidia) very abundant intra- or extra-matrical spherical to subspherical or ellipsoid, 30 to 45  $\mu$  in diameter, mostly terminal and occasionally intercalary, germinating vegetatively in water in a few hours; oögonia and antheridia never observed either in young or old cultures on different substrata; oöspores observed only in the tissues of hosts, 17 to 25  $\mu$  in diameter (the presence or identity of the antheridia has never been established satisfactorily); differing from *P. splendens* Braun in

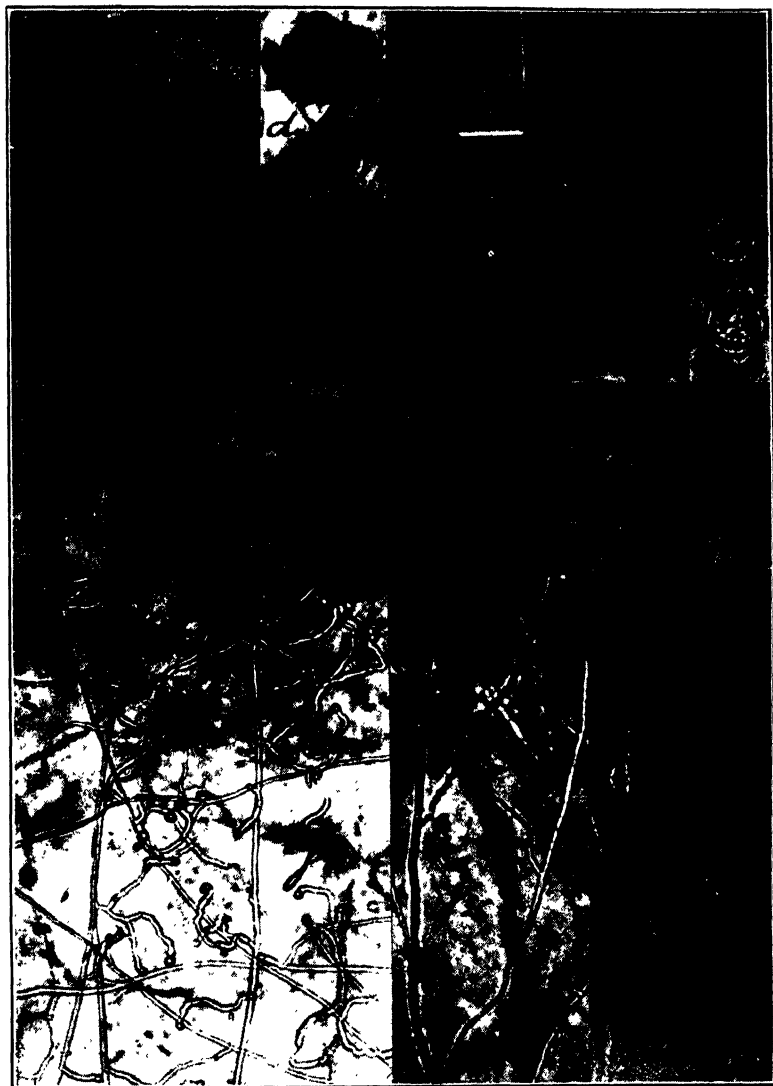


FIG. 7. *Pythium diameson* Sideris: *a*, *b*, *c*, zoösporangia ( $\times 300$ ); *d*, prosporangium intracellular, zoösporangium extracellular ( $\times 600$ ); *e*, *f*, zoöspores ( $\times 300$ ), *f*<sub>2</sub>, ( $\times 600$ ); *g*<sub>1</sub>, *g*<sub>2</sub>, conidia ( $\times 300$ ); *g*<sub>3</sub>, germinating; *g*<sub>3</sub>, *g*<sub>4</sub>, conidia ( $\times 600$ ); *h*<sub>1</sub>–*h*<sub>6</sub>, sexual organs and oöspores ( $\times 600$ ); *h*<sub>8</sub>–*h*<sub>10</sub>, sexual organs ( $\times 300$ ); *i*<sub>1</sub>–*i*<sub>2</sub>, empty prosporangia ( $\times 300$ ); *j*<sub>1</sub>–*j*<sub>2</sub>, hyphae ( $\times 150$ ); *j*<sub>3</sub>, hyphae ( $\times 300$ ) (in unfavorable culture media).



the stronger aerial mycelial development and the size of the conidia, which measure on an average about  $5\ \mu$  more in diameter.

It was first obtained from diseased pineapple roots grown in various fields and in the greenhouses of the Experiment Station at Wahiawa on the island of Oahu of the Hawaiian Archipelago. It is a very aggressive parasite of the roots of *Ananas sativus*, a moderate one of the roots of *Cajanus indicus*, *Phaseolus aureus*, *Vigna sinensis*, *Vicia faba*, *Triticum vulgare*, *Ipomoea Batatas*, *Canavalia ensiformis*, *Helianthus annuus* and a weak one of those of *Saccharum officinarum* var. Lahaina.

13. **P. teratosporon** sp. nov. (FIG. 5, E AND F; FIG. 13).

Mycelium intra- and extra-cellular, on culture media (*Carica Papaya*) exhibiting a strong aerial development; colony slightly zonate and arachnoid; hyphae regular, 7 to  $10\ \mu$  (average  $8.5\ \mu$ ) in diameter; asexual reproduction metaspore; conidia spherical to subspherical or teratomorphic, that is, of irregular and monstrous shapes; oögonia spherical intra- and extra-cellular, 22 to  $28\ \mu$  in diameter, occurring in the tissues of hosts, but never observed in culture media; antheridia never observed; oöspores spherical, aplerotic, 18 to  $22\ \mu$  in diameter, observed in the tissues of the roots of *Cajanus indicus*.

Mycelio acrio plene maturo; colonis zonatis et arachniformibus; hyphis uniformibus, 7–10  $\mu$ ; regeneratione asexuale metasporeica; conidiis subsphaericis et teratoformibus; oögoniis sphaericis, 22–28  $\mu$ ; oösporis sphaericis, apleroticis, 18–22  $\mu$ .

It was obtained from the diseased roots of *Spinacea oleracea* grown on the island of Oahu of the Hawaiian Archipelago. It was found to be a very weak parasite on inoculation on the roots of *Ananas sativus* and *Zea Mays* and a moderate one on those of *Cajanus indicus* var. New Era and *Allium Cepa*. This organism is one of those whose position is doubtful. Its only relationship in the genus *Pythium* is that with *P. splendens* Braun and in *Phytophthora*, judging from its mycelium, with *P. parasitica*, which is also very remote. It is more closely related to *Pseudopythium phytophthoron* than to any other organism in the Pythiaceae.

14. **P. irregulare** Buisman, var. **hawaiiense** var. nov. (FIG. 4, A; FIG. 6, E; FIG. 16). (Buisman, C. J. 2)

Mycelium intra- and extra-cellular, in culture media exhibiting moderate to weak aerial development; hyphae relatively regular,

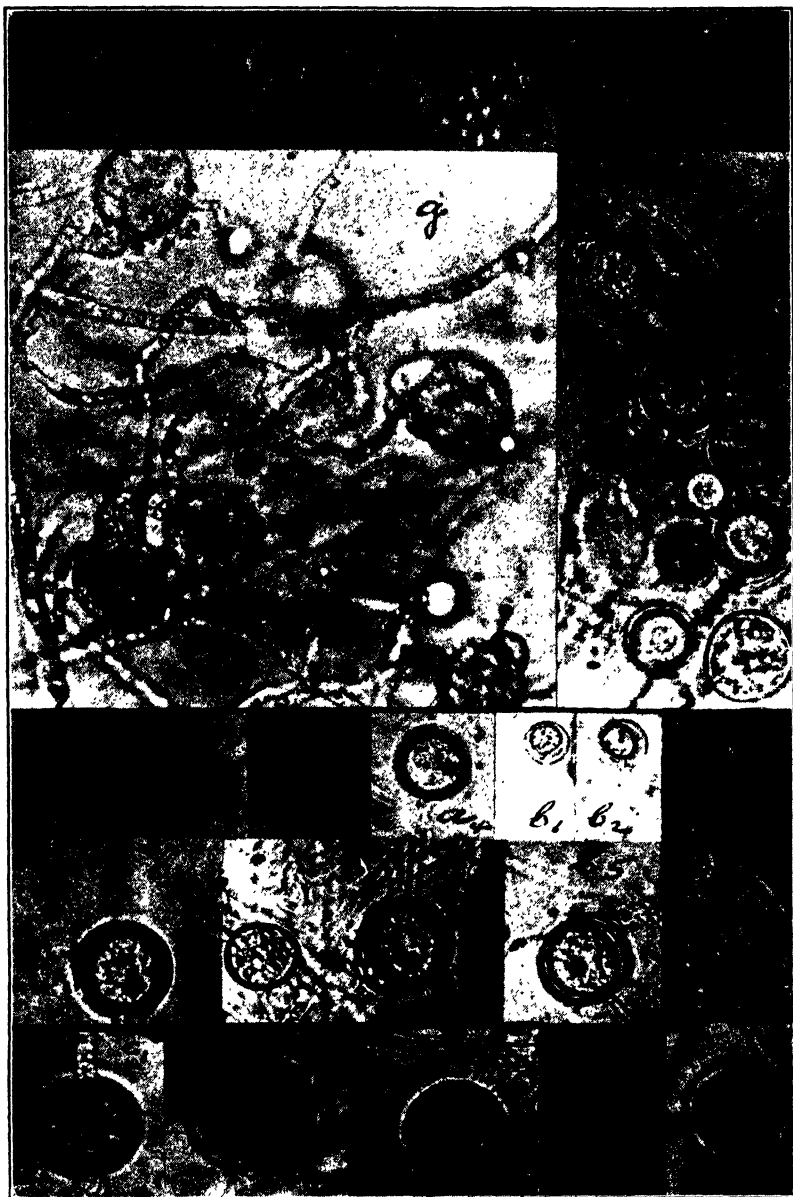


FIG. 8. *Pythium plerosporon* Sideris: (a-b)  $a_1$ - $a_4$  and  $b_1$ - $b_2$ , oöspores ( $\times 600$ );  $b_1$ - $b_2$ , sexual organs ( $\times 300$ ). *Pythium araiosporon* (c-d):  $c_1$ - $c_6$ , oöspores ( $\times 300$ ); d, hyphae ( $\times 600$ ). *Pythium complectens* Braun. (e-f):  $e_1$ - $e_6$ , prosperangia and zoösporangia ( $\times 300$ ); f, zoöspores ( $\times 300$ ); g, sexual organs ( $\times 600$ ); h, oöspores ( $\times 600$ ).

3 to 6  $\mu$  in diameter; asexual reproduction metasporic; conidia rare, 20 to 25  $\mu$  in diameter, mostly intercalary; oögonia spherical to subspherical, 18 to 22  $\mu$  in diameter, smooth, borne mostly on laterals, terminal and intercalary; antheridia clavate, slightly or decidedly curved, 10 to 15  $\mu$  in length along axis from apex to the delimiting septum of supporting filament and 6 to 9  $\mu$  in diameter, one or as many as four in relation to an oögonium; oöspores smooth to echinulate, aplerotic, 12 to 18  $\mu$  in diameter, cell wall 1 to 1.2  $\mu$  in thickness, number of spines indefinite, from one to many, 2 to 8  $\mu$  in length by 2.5  $\mu$  in diameter; it differs from *P.*

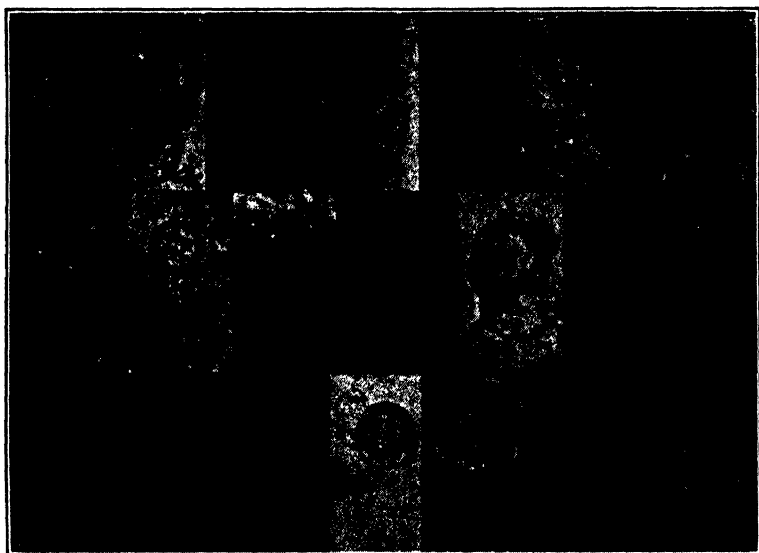


FIG. 9. *Pythium ascophallon* Sideris:  $a_1$ ,  $a_2$ , oögonia ( $\times 600$ );  $b_1$ ,  $b_2$ , beginning fertilization ( $\times 300$ ); note ascomorphic antheridium;  $b_3$ ,  $b_4$ , recently fertilized ( $\times 600$ ); unlabeled illustrations are oöspores ( $\times 600$ ).

*irregulare* Buisman (3) in the size of the oöspores, fewer conidia, nonproduction of zoöspores and stronger aerial mycelium development.

It was first obtained from the diseased roots of *Ananas sativus* grown on the island of Oahu of the Hawaiian Archipelago. It was found on inoculation to be a moderate to severe parasite on the roots of *Ananas sativus*, *Cajanus indicus*, *Phaseolus aureus*, *Vicia faba*, *Ipomoea Batatas*, *Canavalia ensiformis* and *Helianthus annuus*.

15. ***P. polymorphon*** sp. nov. (FIG. 4, B; FIG. 6,  $c_1$ ,  $c_2$ ,  $c_3$ ; FIG. 17).

Mycelium intra- and extra-cellular, in culture media (*Carica Papaya*) exhibiting a very profuse aerial development; hyphae

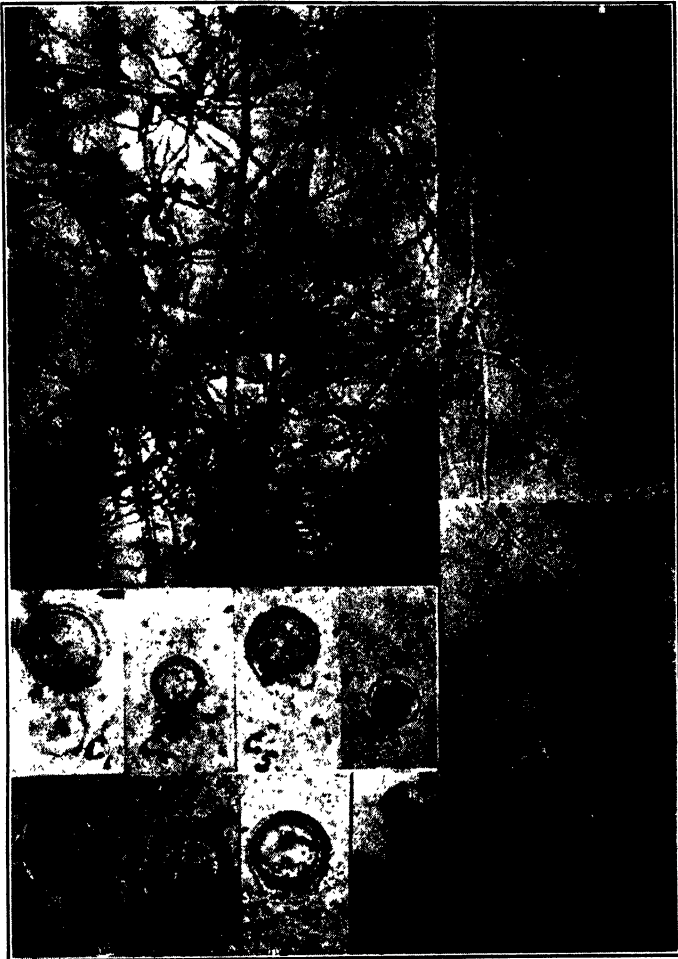


FIG. 10. *Pythium allantocladon* Sideris: *a*, hyphae with allantoid bodies ( $\times 300$ );  $c_1$ – $c_4$ , oöspores ( $\times 600$ );  $c_5$ , recently fertilized oögonium ( $\times 600$ );  $c_6$ , recently fertilized ( $\times 300$ );  $c_7$ , oöspore at the tip of an allantoid body.

mostly regular,  $8\mu$  in diameter, laterals  $4\mu$  in diameter; asexual reproduction metaspore; conidia subspherical to ellipsoid, 20 to  $40\mu$  (average  $30\mu$ ) in diameter, many, and mostly intercalary on

aerial mycelium; oögonia subspherical, 20 to 22  $\mu$  in diameter, smooth, terminal and intercalary, mostly on laterals; antheridia clavate, 7.5  $\mu$  in diameter in the distal expanded portion by 8 to 12  $\mu$  in length along axis from apex to basal septum, supporting

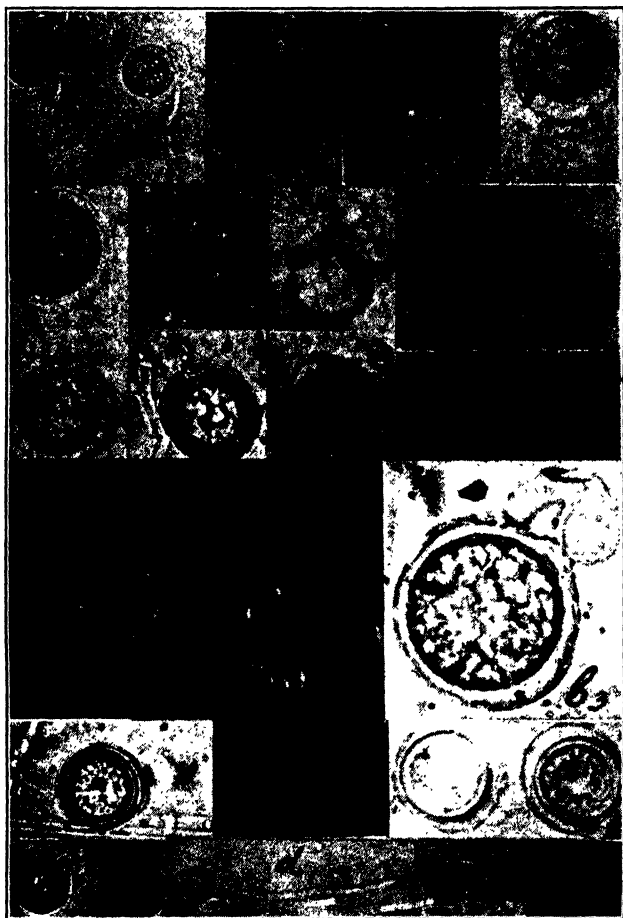


FIG. 11. *Pythium Debaryanum* Hess.:  $a_1, a_2$ , oögonium (the same) at the beginning of fertilization and 30 minutes later ( $\times 300$ );  $b_1, b_2, b_3$ , oöspores ( $\times 1000$ );  $c_1, c_2, c_3$ , oöspores ( $\times 300$ );  $d_1, d_2$ , conidia ( $\times 300$ ); unlabeled illustrations are oöspores at different stages ( $\times 600$ ).

filament falcate to sigmoid, relatively long and originating either from the oögonial hypha or some other; two mostly in relation to a single oögonium and often one or three; oöspores spherical to subspherical, aplerotic, 17 to 20  $\mu$  in diameter, wall 1.2  $\mu$  in thick-

ness, some smooth and others echinulate, number of spines one to many. It has been observed that culture media favoring the production of many conidia inhibit that of oöspores and vice versa. *Carica Papaya* media treated with 1.0 gram of  $K_2HPO_4$  favor the development of oöspores while inhibiting at the same time that of conidia. Untreated *Carica Papaya* media behave in the opposite direction.

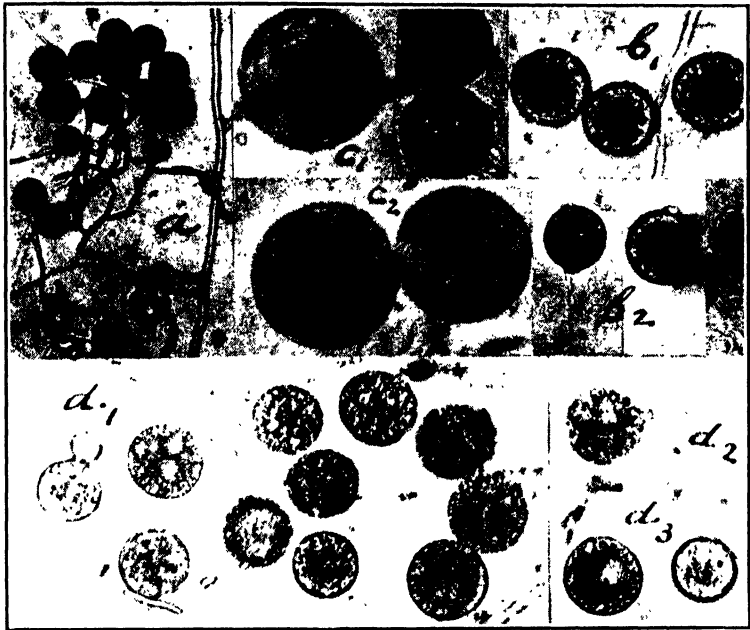


FIG. 12. *Pythium splendens* Braun var. *hawaiiianum* (a-c): a, conidiophore (branched) and conidia ( $\times 150$ ); b<sub>1</sub>, b<sub>2</sub>, terminal and intercalary conidia ( $\times 300$ ); c<sub>1</sub>, c<sub>2</sub>, terminal conidia ( $\times 600$ ). *P. splendens* Braun: d<sub>1</sub>-d<sub>3</sub>, conidia ( $\times 300$ ).

Mycelio aërio plene maturo; hyphis uniformibus, 4-8  $\mu$ ; regeneratione asexuali metaspórica; conidiis subsphaericis, ellipticis, intercalaribus et terminalibus, 20-40  $\mu$ ; oögoniis sphaericis, levibus, terminalibus et intercalaribus, 20-22  $\mu$ ; antheridiis clavatis, 8-12  $\times$  6-7.5  $\mu$ ; oösporis sphaericis, apteroticis, levibus vel echinulatis, 17-20  $\mu$ .

It was obtained from diseased roots of *Ananas sativus*. Also a similar culture was sent to the writer by Dr. W. D. Valleau of the University of Kentucky, isolated from the diseased roots of tobacco. It was found on inoculation to be moderately to aggressively parasitic on the roots of *Ananas sativus*.

16. *P. MAMILLATUM* Meurs. (FIG. 20, B).

(Ein neuer Würzelbranderreger der Zucker- und Futterrüben, Phytopathologische Zeitschrift 1: 111–116. 1929.)

Mycelium intra- and extra-cellular, in culture media exhibiting a weak to moderate aerial development; colony slightly rosette; hyphae fairly regular, 5 to 8  $\mu$  in diameter; asexual reproduction mostly metasporic, rarely orthosporic, prosperangia and conidia spherical, 14 to 21  $\mu$  in diameter; oögonia spherical to subspherical, 20 to 30  $\mu$  in diameter, terminal or intercalary; antheridia clavate,

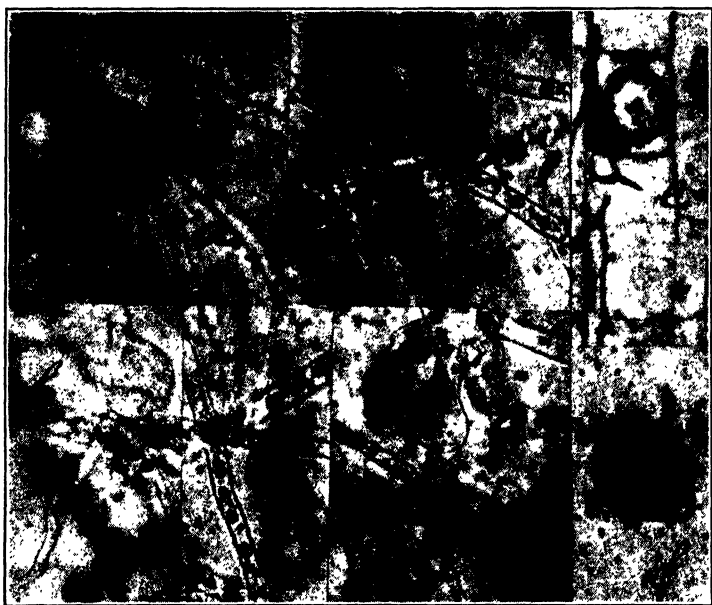


FIG. 13. *Pythium teratosporon* Sideris: a, b, c, d, conidia ( $\times 300$ ); e, f, oöspores ( $\times 600$ ).

10 to 15  $\mu$  in length by 6  $\mu$  in diameter; oöspores spherical, spiny, with the spines 20.3 to 29.3  $\mu$  in diameter, without the spines 13.0 to 19.3  $\mu$  (average 16.4  $\mu$ ), cell wall 0.8 to 1.6  $\mu$  in thickness, spines blunt 2.7 by 6.0  $\mu$ .

It was first obtained by Meurs (7) from the diseased roots of *Beta vulgaris*. It is a weak to moderate parasite of the roots of *Ananas sativus*.

17. **P. Artotrogus** (Montagne) deBary var. **macracanthum** var. nov. (FIG. 4, c; FIG. 6, g; FIG. 18).

(*Artotrogus hydnosporus* Montagne; Berk. Gard. Chron., 1845: 640, and Jour. Royal Hort. Soc. 1: 33. 1846.) (deBary, A. Verh. Senck. Ges. 12: 1881, pl. I.); Butler (4).

Mycelium intra- and extra-cellular, in culture media (*Carica Papaya*, etc.) exhibiting a strong aerial development; hyphae branching, 3 to 6  $\mu$  in diameter, laterals occasionally with allantoid bodies; asexual reproduction mostly metaspore; conidia spherical to subspherical, 20 to 30  $\mu$  in diameter, mostly intercalary; oögonia spiny, terminal and very often intercalary, 20 to 30  $\mu$  in diameter, produced intra- and extra-cellularly; antheridia unicellular, cylindrical to club shaped tapering gradually towards delimiting septum, 10 to 14  $\mu$  in length by 5 to 7  $\mu$  in diameter, hypogynous or epigynous, mostly one in relation to a single oögonium; oöspores, echinulate, 15 to 25  $\mu$  in diameter without the spines and with the spines 30 to 45  $\mu$  in diameter, cell wall 1.5 to 2.0  $\mu$  in thickness, spines 7.5 to 10  $\mu$  in length by 1.0 to 1.5  $\mu$  in diameter. It differs from *P. Artotrogus* (Mont.) deBary (FIG. 20-A) in having some epigynous antheridia in the greater length of the spines of its oöspores and the greater amount of aerial mycelium produced by culture media.

It was first obtained from the diseased roots of *Ananas sativus* grown on the islands of Oahu and Maui of the Hawaiian Archipelago. The organism was found on inoculation to kill the roots of *Ananas sativus*, *Saccharum officinarum* var. *Lahaina*, *Pennisetum barbinodum*, *Cajanus indicus*, *Phaseolus aureus*, *Ipomoea Batatas*, *Canavalia ensiformis* and *Vigna sinensis*.

18. **P. diameson** sp. nov. (FIG. 1, D; FIG. 6, A; FIG. 7).

Mycelium intra- and extra-cellular, in culture media exhibiting a weak to moderate aerial development; hyphae irregular, about 5  $\mu$  in diameter with constrictions, swellings, and occasionally few spiroid formations, laterals short terminating to cylindrical or slightly clavate branches with blunt and partly swollen tips; asexual reproduction orthospore and metaspore, prosorangia subspherical, 15 to 20  $\mu$  in diameter, mostly intracellular, producing zoösporangia extracellularly, the latter measuring about 25  $\mu$  in diameter and containing 8 to 24 zoöspores, exit tube piercing the cell wall of the host before emergence of zoösporangium takes place; conidia subspherical same size as prosorangia pro-



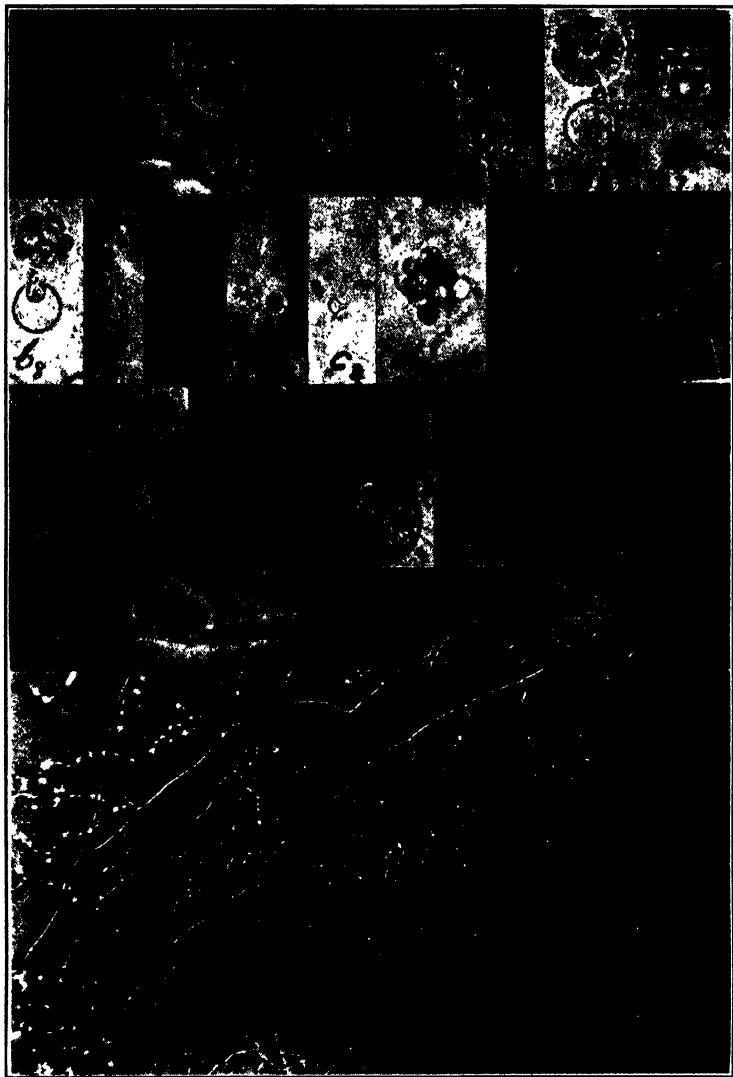


FIG. 14. *Pythium polycladon* Sideris:  $a_1$ , prosporangium ( $\times 300$ );  $a_2$ , conidia ( $\times 300$ );  $a_3$ ,  $a_1$ , conidia, one having germinated ( $\times 600$ );  $b_1$ - $b_3$ , prosporangia with zoösporangia and different stages in the development of zoöspores ( $\times 300$ ) except  $b_3$ , ( $\times 150$ );  $c_1$ - $c_3$ , empty prosporangia ( $\times 300$ );  $c_3$ , ( $\times 150$ );  $d_1$ - $d_3$ , germinating zoöspores ( $\times 300$ );  $d_4$ , zoöspore entering a root hair and  $d_5$  having entered it;  $e_1$ - $e_3$ , gemmae ( $\times 600$ );  $e_3$ , ( $\times 300$ );  $f$ , type of branching of hyphae ( $\times 150$ ).

duced in culture media, borne on the tips of unbranched or single conidiophores; zoöspores reniform with slightly pointed ends and a curvature at a deep hilum, motility lasting 5 to 15 minutes, then rounding up into subspherical bodies, 8 to 10  $\mu$  in diameter which may germinate in a few hours by one and rarely by two germ tubes;

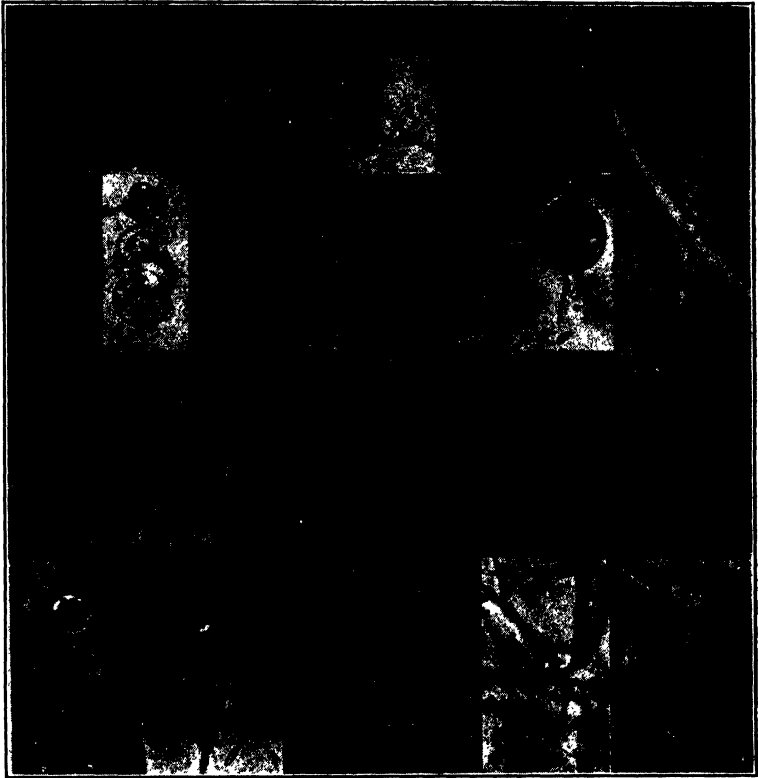


FIG. 15. *Pythium cutyhyphon* Sideris: *a*, prosporangium ( $\times 300$ ); *b*<sub>1</sub>-*b*<sub>4</sub>, prosporangia with zoösporangia and different stages in the development of zoöspores ( $\times 300$ ); *c*, empty prosporangium; *d*<sub>1</sub>-*d*<sub>3</sub>, zoöspores ( $\times 600$ ); *e*<sub>1</sub>, conidium ( $\times 600$ ); *e*<sub>2</sub>-*e*<sub>3</sub>, conidia ( $\times 300$ ); *f*, hyphae and allantoid bodies. *Pythium chamaihyphon* Sideris: *g*<sub>1</sub>, prosporangium before germination ( $\times 300$ ); *g*<sub>2</sub>, prosporangium discharging contents ( $\times 300$ ); *g*<sub>3</sub> and *g*<sub>4</sub>, prosporangia and zoösporangia ( $\times 300$ ).

oögonia intra- and extra-cellular, lateral and occasionally intercalary; spherical to subspherical, thin walled, measuring 15 to 17  $\mu$  in diameter; antheridia, clavate, oögonial hyphae, 9 to 11  $\mu$  in length by 4 to 6  $\mu$  in diameter, one and occasionally two in relation to a single oögonium; oöspores spherical intra- and extra-cellular,

plerotic, single, about  $15\ \mu$  in diameter, wall  $1\frac{1}{2}$  to  $2\ \mu$  in thickness, produced in great numbers in suitable culture media and in the tissues of hosts.

*Mycelio aerio mediocri*; hyphis irregularis,  $5\ \mu$ ; regeneratione asexuali orthosporica et metasporica; prosperangiis sphaericis, intercellularibus et extracellularibus,  $15\text{--}20\ \mu$ ; zoösporis reniformibus,  $8\text{--}24\ \mu$ ; conidiis subsphaericis; oögoniis intracellularibus et extracellularibus, subsphaericis,  $15\text{--}17\ \mu$ ; antheridiis clavatis; oösporis sphaericis, apleroticis, singularibus,  $15\ \mu$ .

It was first obtained from the diseased roots of *Ananas sativus* grown in Field No. 209 of the Maui Agricultural Company on the island of Maui. It was found on inoculation, to be pathogenic on the roots of *Ananas sativus*, *Pennisetum barbinodum*, *Zea Mays*, *Saccharum officinarum* var. Lahaina, *Cajanus indicus*, *Vicia faba*, *Solanum tuberosum*, *Ipomoea Batatas*, and *Canavalia ensiformis*.

19. **P. plerosporon** sp. nov. (FIG. 3, B; FIG. 8).

Mycelium lacking aerial development on culture media; colony rosette; hyphae regular, 2 to  $5\ \mu$  (average  $3.5\ \mu$ ) in diameter; asexual reproduction extremely rare, metasporic; oögonia spherical, 16 to  $20\ \mu$  in diameter, mostly intramatrix on laterals; antheridia clavate, 10 to  $14\ \mu$  in length along axis from apex to basal septum by 8 to  $10\ \mu$  in diameter at the distal expanded portion, mostly on oögonial hyphae, mostly one in relation to a single oögonium; oöspores spherical, mostly terminal, plerotic, 12 to  $18\ \mu$  (average  $15\ \mu$ ) in diameter, wall 1 to  $2\ \mu$  in thickness, germinating by a single germ tube, occasionally by more.

*Mycelio aerio mediocriter maturo vel ferme nullo in culturis in patellis*; coloniis "rosette"; hyphis uniformibus,  $2\text{--}5\ \mu$ ; regeneratione asexuali infrequente, metasporica; oögoniis sphaericis,  $16\text{--}20\ \mu$ ; antheridiis clavatis,  $10\text{--}14 \times 8\text{--}10\ \mu$ ; oösporis sphaericis, terminalibus, pleroticis,  $12\text{--}18\ \mu$ .

It was sent to the writer by Dr. W. D. Valleau of the University of Kentucky, obtained from the diseased roots of tobacco.

## DISCUSSION

The attempt has been made in the foregoing pages to present a classification of the different members of *Pythium* from a different point of view than the one heretofore presented by other investigators. Characters that previously occupied a secondary or tertiary position are given a primary position in this presentation and vice versa. The writer's point of view is that morphological char-

acters associated with the sexual reproductive organs are liable to undergo slower changes and, therefore, are more stable than those associated with the asexual reproductive organs. The morphology of the oöspores and, to a certain extent, of the antheridia of all species of *Pythium* is fairly constant except for normal varia-

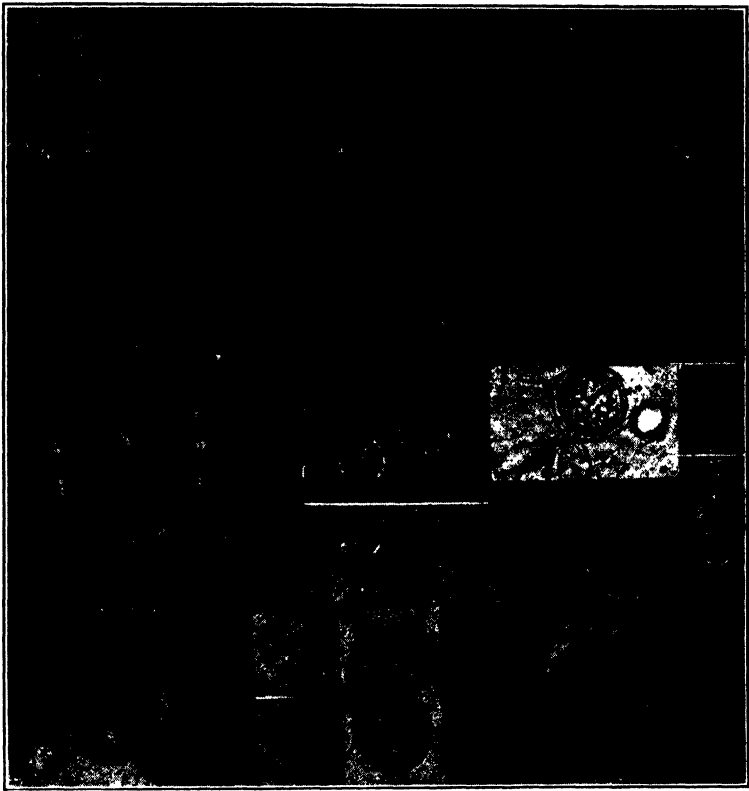


FIG. 16. *Pythium irregulare* Buisman var. *hawaiiianum*: *a*, *b*, oöspores (polymorphic) ( $\times 1000$ ); *c*, oögonium and oöspores ( $\times 300$ ); unlabeled illustrations are oöspores and oögonia ( $\times 600$ ).

tions. They are not susceptible to slight changes in their environment and nutrition. Furthermore morphological similarities of these organs between different species can be relied upon as representing some sort of relationship between such species.

With this point in view, the relationship existing between different species may be approximately ascertained by the common

characters existing in their antheridia and oöspores. There are four distinct types of oöspores (1) the smooth plerotic, (2) the smooth applerotic, (3) the polymorphic applerotic, and (4) the acanthophoric. There are, likewise, two distinct types of antheridia (1) the clavate and (2) the ascomorphic. The allantoid type of antheridium is but a slightly modified form of the ascomorphic type.

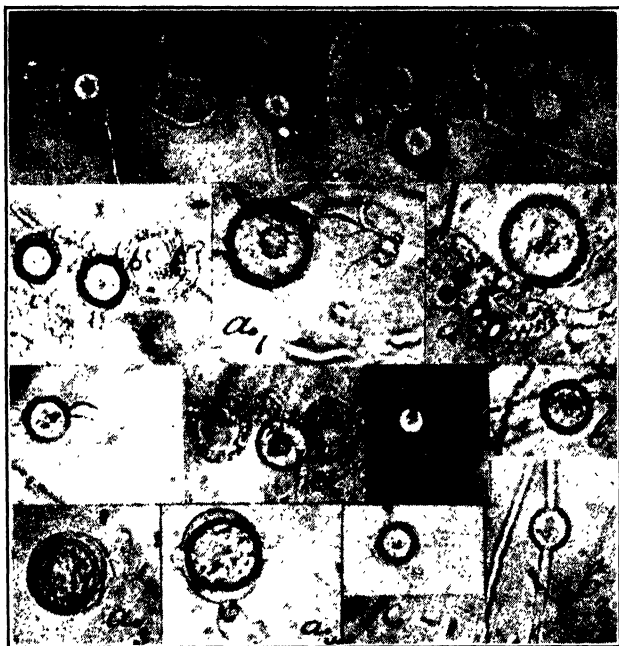


FIG. 17. *Pythium polymorphon* Sideris:  $a_1$ – $a_3$ , sexual organs ( $\times 600$ );  $b_1$ ,  $b_2$ , conidia ( $\times 300$ );  $c$ , oöspore with one spine ( $\times 300$ ); unlabeled illustrations are sexual organs ( $\times 300$ ).—Note type of antheridium.

It may be beyond our experimental possibilities to establish the precedence of any one of the different types of oöspores or antheridia in the evolution of the different species of *Pythium*. But by comparative morphological studies and reasoning, we are led to accept the smooth applerotic type of oöspore and the ascomorphic type of antheridium as being the most elementary types. The applerotic type of oöspore, that is, the one not filling the oögonium, occurs in the majority of the species of *Pythium*, and may be

fertilized by the clavate or ascomorphic type of antheridium. The ascomorphic type represents the most elementary type of antheridium owing to its initial shape and the modifications it undergoes during its development and after fertilization, which suggest its prototypic condition. The development of the other types of oöspores and antheridia has come about either by reduction of the original size or in the case of certain oöspores by modifications of the unfilled portion of the oögonium.

The evolution of the different species of *Pythium* as represented in figure 21 does not follow a straight line. It is very difficult to trace the descent of either the genus or the different species or the evolutionary development of their sexual organs with the small number of species already known. The number of prototypic organisms known is very small and not even sufficiently elementary for studies dealing with the evolution of such a complex genus as *Pythium*. The relationship existing between *Pythium* and the other genera of Pythiaceae such as *Nematosporangium*, *Phytophthora*, *Pseudopythium*,<sup>3</sup> etc., cannot be made with any degree of accuracy. The same is true also of the different species of *Pythium*. The evolutionary tree of *Pythium* shows too much basal branching, that is, the various groups of interrelated species show that they have originated independently from some prototypic forms of which we have no representatives among our present collections. *Nematosporangium* and *Pythium* have doubtless sprung from the same bud, whereas, *Pseudopythium* and *Phytophthora* have probably sprung from some very elementary forms of *Pythium*. The arrangement of the different groups is in conformity with the degree of relationship of the different species. The tree is divided into two main branches, the one representing the species with ascomorphic antheridia and the other those with cylindrical to clavate antheridia, *P. complectens* being the most typical species of the former, and *P. Debaryanum* of the latter. These main branches are further subdivided into smaller branches representing the groups of species differentiated by either different types of oöspores, or different types of prosperangia. The different groups are as follows: (1) Those with smooth aplerotic oöspores, clavate antheridia and spherical to subspherical conidia;

<sup>3</sup> A new genus described in a paper following.

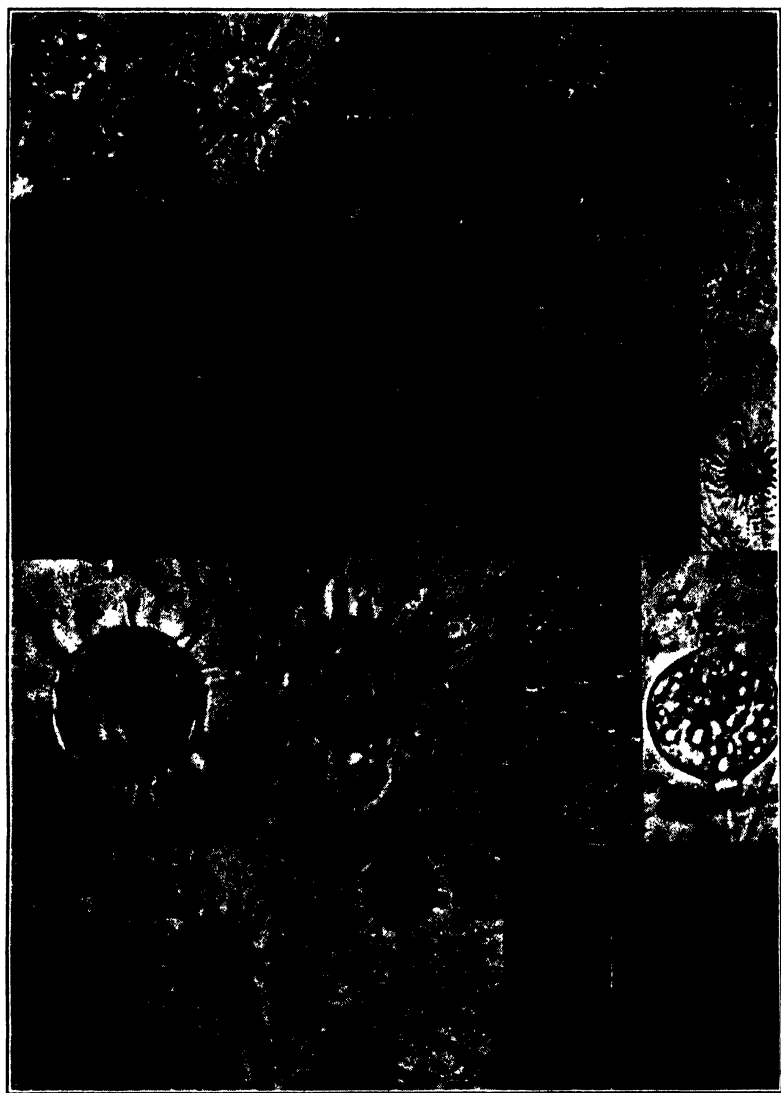


FIG. 18. *Pythium Artotrogus* var. *macracantha* Sideris: *a*<sub>1</sub>-*a*<sub>5</sub>, sexual organs ( $\times 300$ ); *b*, sexual organs ( $\times 150$ ); *c*<sub>1</sub>-*c*<sub>3</sub>, oöspores ( $\times 1000$ ); *d*<sub>1</sub>-*d*<sub>2</sub>, conidia ( $\times 1000$ ); *e*<sub>1</sub>-*e*<sub>3</sub>, conidia ( $\times 600$ ); unlabeled figures are oöspores ( $\times 600$ ); *f*, oöspore ( $\times 600$ ).—Note oögonial membrane surrounding spore not formed into spines.

(2) those with polymorphic aplerotic oöspores, clavate antheridia and spherical to subspherical conidia; (3) those with smooth aplerotic oöspores, clavate antheridia and spherical to subspherical

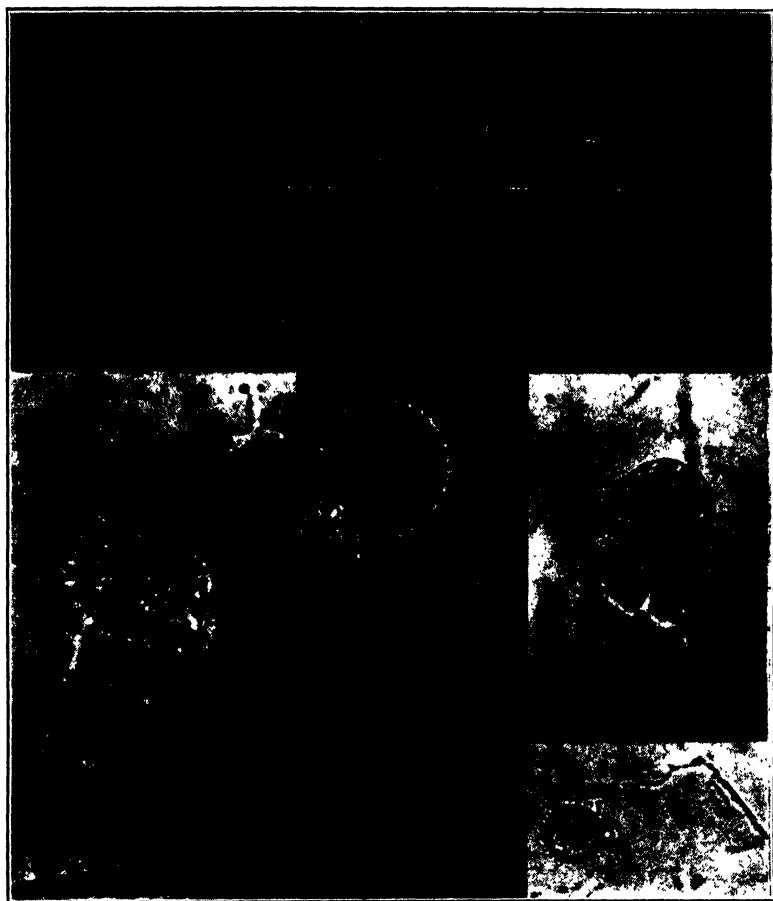


FIG. 19. *Pythium acanthophoron* Sideris: *a*, oogonium ( $\times 600$ ); *b*<sub>1</sub>–*b*<sub>3</sub>, sexual organs at the beginning of fertilization ( $\times 600$ ); unlabeled figures represent sexual organs and oöspores ( $\times 600$ ).—Note ascomorphic to allantoid antheridium.—Note ascomorphic antheridia.

conidia; (4) those with clavate antheridia and acanthophoric aplerotic oöspores; (5) those with ascomorphic antheridia, smooth aplerotic oöspores and spherical to subspherical conidia; (6) those with allantoid (ascomorphic) antheridia, acanthophoric aplerotic



oöspores and spherical to subspherical conidia, and (7) those with smooth aplerotic oöspores (antheridia not carefully studied), and lemon-shaped to subspherical conidia. Each group, although containing organisms having many characters in common, does not represent by any means, a very homogeneous assemblage. The groups or assemblages presented in this treatise constitute units of organisms having one or two morphological characters in common, and therefore approximately related. In figure 21 an attempt has been made to represent the phylogenetic relationship of the different species. The morphology of the conidia or prosporangia had to be considered besides that of the oöspores and antheridia in order that the different organisms be placed in as homogeneous groups of related species as possible. The citroform and subspherical form of the prosporangia of such species as *P. euthyhyphon* and *P. polycladon* shows slight resemblance to that of species of *Phytophthora*. The cultural characters and physiological behavior of *P. teratosporon* bear likewise close resemblance to those of *Pseudopythium*.

There are many such heterogeneous species, in the genus *Pythium*, indicating that our present species originated from ancestral clons with many morphological differences. The subdivision of *Pythium* into the tribes *Platyphalla* and *Stenophalla*, on the basis of the morphology of their antheridia, does away with some of the most confusing features of this genus. The morphology of the antheridium has in the past been given very little attention in the differentiation of species and still less in the segregation of groups of such species, probably, because its morphological differences are less prominent than those of some other organs. While the main subdivision on the basis of antheridium morphology is difficult to establish in mature material, it is usually very clear just prior to fertilization. The antheridia of *Platyphalla* show their ascomorphic shape more prominently before fertilization than after. Those of *Stenophalla* being usually clavate and narrow change very little, if any, before and after fertilization. The subdivision of the two tribes into the sections *Plerospora* and *Aplerospora* differentiates two distinct groups of organisms on the basis of the behavior of their oöspores in relation to the oögonium. The aplerotic type of oöspore occurs more often than the plerotic type.

The author's opinion is that the aplerotic type represents a more elementary form than the plerotic type. This assumption is made

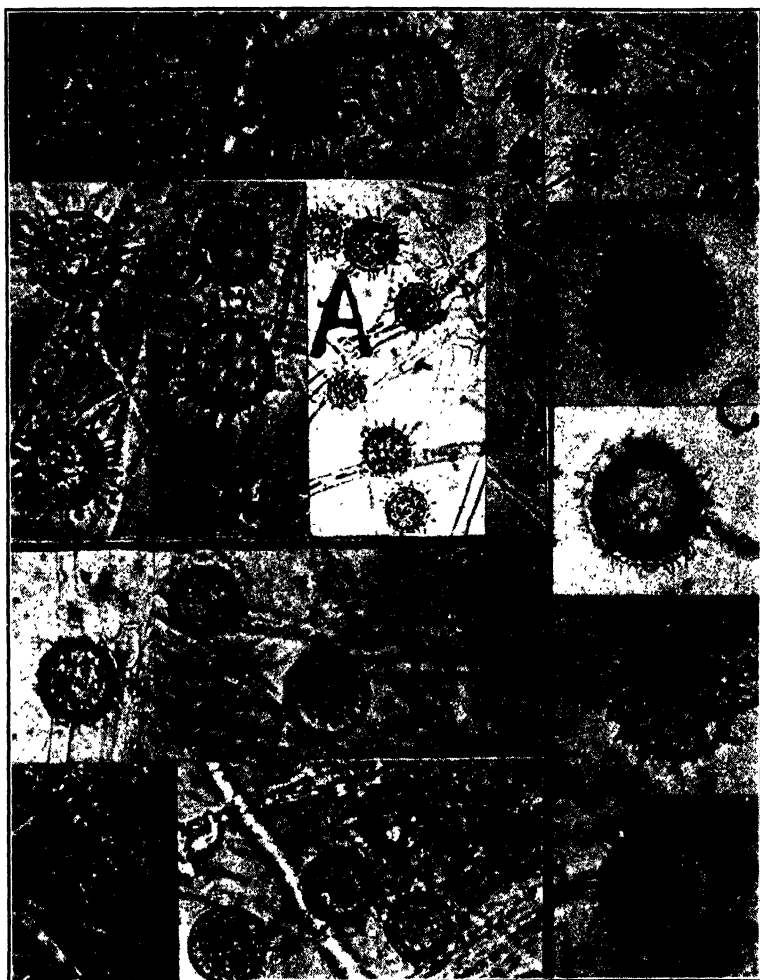


FIG. 20. (A) *Pythium Artotrogus* (Mont.) deBary: oöspores: large ( $\times 600$ ), small ( $\times 300$ ); (B) *Pythium mamillatum* Meurs: oöspores and oögonia ( $\times 600$ ); (C) *Pythium megalacanthum* deBary: oöspores and oögonium ( $\times 600$ ).

on the basis of the wider distribution of the aplerotic type of oöspores in the majority of species of the genus *Pythium* and those of the genera of the family Saprolegniaceae.



The further subdivision of the above two sections into the subsections *Leiospora*, *Polymorphospora* and *Acanthospora* is based on the superficial morphology of the oöspores or rather the oögonial membrane surrounding such oöspores. The oögonial membrane surrounding the oöspores of the section *Aplerospora* may either retain its original smoothness or collapse and form either irregularly or regularly shaped wrinkles which develop in certain species into spines. In the section *Plerospora* such wrinkles or spines never occur. The various subsections could not be satisfactorily subdivided further into groups on the basis of the orthosporic or metasporic behavior of their prosperangia. Such classification could not be very reliable, because external conditions, such as chemical composition of the substratum and temperature, or internal conditions, such as age of the prosperangia may influence or inhibit the development of the one form of reproduction or the other. It has been found that different varieties of the same species may be either orthosporic or metasporic.

*Pythium intermedium* reproduces only asexually according to the findings of the writer and those of other investigators. Such a behavior has been acquired possibly in the long process of its evolution through the influence of environmental factors. It is doubtless related to *P. complectens* on the one hand and to *P.*

## STENOPHALLA.

## APLERSPORA. (Section)

*Leiospora*. (Subsection)

Metasporic <sup>1</sup>	.....	<i>P. Debaryanum</i> (11)
"	.....	<i>P. araiosporon</i> (12)
"	.....	<i>P. splendens</i> (18)
"	.....	<i>P. teratosporon</i> (19)

*Polymorphospora*. (Subsection)

Metasporic <sup>1</sup>	.....	<i>P. irregulare</i> (15)
"	.....	<i>P. polymorphon</i> (16)

*Acanthospora*. (Subsection)

Metasporic <sup>1</sup>	.....	<i>P. mamillatum</i> (8)
"	.....	<i>P. Artotrogon</i> (17)

## PLERSPORA. (Section)

*Leiospora*. (Subsection)

Orthosporic	.....	<i>P. diameson</i> (13)
Metasporic	.....	<i>P. plerosporon</i> (14)

<sup>1</sup> Mostly metasporic and very rarely orthosporic.

*chamaihyphon* on the other as the form of their conidia is practically identical and the production of oöspores in both organisms is always at the expense of their conidia or vice versa. It is likely that *P. intermedium* behaved in some similar manner until the process of conidia formation became the dominant process in its reproduction.

The total number of species with spiny oöspores cannot be grouped together for there are many morphological differences indicating the independent evolution of the two groups. The species with polymorphic and with spiny oöspores such as *P. polymorphon*, *P. irregulare*, *P. mamillatum* and *P. Artotrogus* have likely originated from closely related prototypes, whereas, those of *P. megalacanthum* and *P. acanthophoron* have originated from more distantly related prototypes. The former group is, likewise, more closely related to the group comprising *P. Debaryanum* and allied species and the latter to the group comprising *P. complectens* and allied species.

The conidia or prosperangia, in *Pythium* are recognized according to their form, as spherical, subspherical or ellipsoid, and lemon-shaped; position, as terminal and intercalary; and size, as small and large. There are two types of conidiophores or prosperangio-phores in *Pythium*, the simple or unbranched type possessed by most species and the branched type by few. *P. splendens* possesses branched as well as unbranched conidiophores with large mostly spherical conidia. *P. polycladon* and *P. chamaihyphon* possess branched as well as unbranched conidiophores with spherical to lemon-shaped or ellipsoid conidia. The shape of the conidia of the species included in *Stenophalla* are spherical to ellipsoid and in the greater number of species are smaller (except those of *P. splendens*) than those of the species of *Platyphalla*. The various groups as established give us a true picture of the morphological and possibly phylogenetic relationship of the species presented herewith. The morphological comparisons presented in this discussion, although philosophical to a certain extent, give us, nevertheless, a new angle from which to view the relationship of these different organisms.

The writer wishes to acknowledge his indebtedness to Dr. A. L. Dean and Dr. G. H. Godfrey for reading the manuscript and to

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#### NOTE

"*Pythium tetrasporon* (P. 40, Fig. 13) has been found through later studies of the writer to belong to *Phytophthora* and possibly in the group of organisms related to *Phytophthora cambivora*, and should be considered definitely a species of *Phytophthora*."

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# THE RUSTS OF SOUTH AMERICA BASED ON THE HOLWAY COLLECTIONS—VI<sup>1</sup>

H. S. JACKSON

## SPECIES ON VERBENACEAE

251. *AECIDIUM VERBENAE* Speg. Anal. Soc. Ci. Argent. 9: 174.  
1880.

*Aecidium verbenicola* Speg. Anal. Mus. Nac. Buenos Aires 19:  
323. 1909. (Not Ellis and Kellerm. 1884).

*Aecidium Spegazzinianum* Sacc. & Trott. Syll. Fung. 21: 775.  
1912.

*Aecidium elongatum* Speg. Rev. Argent. Bot. 1: 95. 1925.

*Aecidium verbeniphilum* Speg. Rev. Argent. Bot. 1: 102. 1925.

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*Verbena litoralis* H.B.K. Petropolis, Rio de Janeiro, Brazil,  
Nov. 3, 1921, 1272; Therezopolis, Rio de Janeiro, Oct. 1,  
1921, 1180; Friburgo, Rio de Janeiro, Brazil, Jan. 4,  
1922, 1454.

*Verbena* sp. Barbacena, Minas Geraes, Brazil, Dec. 12, 1922,  
1380; São Paulo, Brazil, Jan. 18, 1922, 1479.

There is some doubt whether or not all the names listed above belong to one species. Spegazzini evidently considered that there were at least two forms. His *A. Verbenae* he thought to be the aecial stage of *Puccinia elongata* Speg. The latter, however, seems, from the description, to be a short cycled form.

<sup>1</sup> Joint contribution from the Department of Botany, University of Toronto, and the Department of Botany, Purdue University Agricultural Experiment Station. Prepared in part (pp. 62-102) with the aid of a grant from the American Association for the Advancement of Science. The sixth of a series of papers bearing the same title. (See Mycologia 18: 139-163. 1926; 19: 51-65. 1927; 23: 96-116, 332-364, 463-503. 1931.) This number completes the series, and is published in full at this time through the aid of the E. W. D. HOLWAY HERBARIUM OF PLANT RUSTS fund, Botany Department, University of Minnesota. A supplementary number with indices is to be published at a later date. The Latin diagnoses in this number were prepared with the aid of Miss Margaret H. Thomson, M.A.

252. *AECIDIUM LANTANAE* Mayor, Mém. Soc. Neuch. Sci. Nat. 5: 567. 1913.

*Lantana lilacena* Desf. Petropolis, Rio de Janeiro, Brazil, Nov. 2, 1921, 1268; Bello Horizonte, Minas Geraes, Brazil, Dec. 1, 1921, 1353.

*Lantana rugulosa* H.B.K. Cuenca, Ecuador, Sept. 13, 1920, 985.

*Lantana* sp. Quito, Ecuador, Aug. 26, 1920, 947.

There may be some question whether this *Aecidium* differs from *A. Verbenae* Speg. It seems best to list it separately for the present. It appears to be reported previously only from Colombia, Nicaragua, and Panama.

253. *ENDOPHYLLUM STACHYTARPHETAE* (P. Henn.) Whetzel & Olive, Am. Jour. Bot. 4: 50. 1917.

*Aecidium Stachytarphetae* P. Henn. Hedwigia Beibl. 38: 71. 1899.

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*Stachytarpheta dichotoma* Vahl. Reserva Florestal, São Paulo, Brazil, May 6, 1922, 1808.

We follow the well established, though entirely illogical, custom of listing this collection as an *Endophyllum*. It should be recognized, because of the obvious origin of *Endophyllum* from *Aecidium*, that it is entirely possible that an *Aecidium* and the *Endophyllum* derived from it may both exist even in the same region. This species has been reported in South America from Brazil, Bolivia, Colombia and Trinidad. It is evidently common also in Porto Rico and Panama.

254. *PUCCINIA LANTANAE* Farl. Proc. Am. Acad. Sci. 18: 83. 1883.

*Uromyces Lantanae* Speg. Anal. Soc. Ci. Argent. 17: 93. 1884.

*Puccinia accedens* Sydow, Monog. Ured. 1: 309. 1902.

*Puccinia Privae* Sydow, Ann. Myc. 5: 338. 1907.

*Uromyces Lippiae* Speg. Anal. Mus. Nac. Buenos Aires 19: 313. 1909.

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*Lantana brasiliensis* Link, Bosque da Saude, São Paulo, Brazil, March 22, 1922, 1667.



*Lantana trifolia* L. São Paulo, Brazil, Jan. 20, 1922, 1483.

*Lippia rhodocnemis* Mart. & Schau. Rio de Janeiro, Brazil, Aug. 9, 1921, 1006.

*Lippia triflora* L. Hacienda Anacuri, Nor Yungas, Bolivia, June 4, 1920, 711.

This very common micro-form has a wide distribution extending from Florida and Mexico throughout the West Indies and less commonly in Central America. In South America it is reported from Colombia, Trinidad, Ecuador, Argentina and Brazil. Mesospores often predominate in the sori and the species may at first be mistaken for a *Uromyces*.

255. ***Puccinia Mariae*** Jackson, sp. nov.

II. Uredosoris hypophyllis, sparsis vel gregariis, rotundatis, 0.2–0.4 mm. diam., mox nudis, cinnamomeo-brunneis, pulverulentis, epidermide rupta inconspicuis; uredosporis obovoideis vel subgloboideis,  $17\text{--}19 \times 19\text{--}22 \mu$ ; tunica pallide cinnamomeo-brunnea, tenui,  $1\text{--}1.5 \mu$ . minute moderateque echinulata, poris 2 aequatorialibus praedita.

III. Teleutosoris uredosoris conformibus, brunneo-nigrescentibus; teleutosporis late ellipsoideis,  $25\text{--}27 \times 30\text{--}38 \mu$ , utrinque rotundatis, medio non vel moderate constrictis; tunica castaneo-brunnea,  $2.5\text{--}3 \mu$  cr., apice leniter incrassata,  $3.5\text{--}4.5 \mu$ , sparse verrucoso-echinulata, verrucis conoideis inter se  $6\text{--}7 \mu$  secernatis; poro loculi inferioris plerumque mediano; pedicello hyalino, fragili, sporam aequante vel plerumque brevior.

*Lippia* sp. Prata, São Paulo, Brazil, Apr. 9, 1922, 1719.

This species is very different from *P. senilis* Arth., in which the teliospore wall bears closely placed tuberculate-verrucose markings and has the apex considerably more thickened. We name the species in honor of Mrs. Mary M. Holway.

256. **PROSPODIUM LIPPIAE** (Speg.) Arth. N. Am. Fl. 7: 161. 1912.

*Puccinia Lippiae* Speg. Anal. Mus. Nac. Buenos Aires 6: 224. 1898.

*Uredo Lippiae* Speg. Anal. Mus. Nac. Buenos Aires 6: 238. 1898.

*Uredo Lippiae* Dietel & Holway; Holway, Bot. Gaz. 31: 335. 1901.

*Lippia hemisphaerica* Jacq. Guayaquil, Ecuador, Aug. 1, 1920, 807.

*Lippia ligustrina* (Lagerh.) Britton, Cochabamba, Bolivia, Feb. 26, 1920, 326, 327.

257. PROSPIDIUM TUBERCULATUM (Speg.) Arth. N. Am. Fl. 7: 161. 1912.

*Uredo tuberculata* Speg. Anal. Soc. Ci. Argent. 9: 172. 1880.

*Puccinia tuberculata* Speg. Anal. Soc. Ci. Argent. 10: 6. 1880.

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*Lantana Camara* L. La Paz, Bolivia, March 26, 1920, 465; Hacienda Anacuri, Nor Yungas, Bolivia, June 3, 1920, 706; São Bernardo, São Paulo, Brazil, Feb. 3, 1922, 1532; Campinas, São Paulo, Brazil, Apr. 2, 1922, 1688.

*Lantana mixta* L. Reserva Florestal, São Paulo, Brazil May 6, 1922, 1811.

All the collections listed above are of uredinia only, but seem to belong as assigned.

#### SPECIES ON LABIATAE

258. PUCCINIA ANNULARIS (Strauss) Schlecht. Fl. Berol. 2: 132. 1824.

*Uredo annularis* Strauss, Ann. Wett. Ges. 2: 106. 1810.

*Puccinia Teucrii* Biv.-Bern. Stirp. Rar. 3: 17. 1815.

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*Teucrium bicolor* Smith, Temuco, Chile, Dec. 5, 1919, 200.

This common European and Asiatic micro-form seems not to have been previously reported from America. The collection listed above, however, appears to fit the description well.

259. PUCCINIA GARDQUIAE Dietel & Neger, in Engl. Bot. Jahrb. 22: 353. 1896.

*Gardoquia tomentosa* H.B.K. Riobamba, Ecuador, Aug. 11, 1920, 870.

This species has apparently been reported previously only from the type locality at Concepcion, Chile. While the collection listed above bears uredinia only, the spores agree well with the original description of this species.

260. PUCCINIA LEONOTIDIS (P. Henn.) Arth. Mycologia 7: 245. 1915.

*Uredo Leonotidis* P. Henn. in Engler, Pfl. Ost.-Afr. C: 52. 1895.

*Uredo leonoticola* P. Henn. Hedwigia, Beibl. 38: 69. 1899.

*Puccinia leonotidicola* P. Henn. in H. Baum, Kun.-Samb. Exp. 2: 157. 1903.

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*Leonotis nepetaefolia* (L.) R. Br. Jardin Bot., Rio de Janeiro, Brazil, Aug. 11, 1921, 1020; Jundiahy, São Paulo, Brazil, Feb. 4, 1922, 1533.

The collections listed are of uredinia only as is the usual situation in this widely distributed tropical rust. The species is common throughout Central America and northern South America, and has been reported previously from Brazil and Argentina. It is also known in western Africa and eastern India.

261. PUCCINIA MENTHAE Pers. Syn. Fung. 227. 1801.

*Bystropogon mollis* H.B.K. Cochabamba, Bolivia, Feb. 26, 1920, 332; Sorata, Bolivia, Apr. 22, 1920, 562; Cuenca, Ecuador, Sept. 10, 1920, 968, 978.

*Bystropogon spicata* Benth. La Paz, Bolivia, May 13, 1920, 601, March 23, 1920, 448; Cuzco, Peru, July 2, 1920, 752; Hacienda del Urco, Urubamba Valley, Cuzco, Peru, July 4, 1920, 762-1/2.

These collections on *Bystropogon* are tentatively referred to this well known species. The teliospores average slightly larger and the wall markings are slightly more definitely echinulate than in most collections of *P. menthae*.

262. PUCCINIA PALLIDISSIMA Speg. Anal. Soc. Ci. Argent. 12: 69. 1881.

*Puccinia albida* Dietel & Neger, in Engl. Bot. Jahrb. 24: 160. 1897.

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*Stachys arvensis* L. Cochabamba, Bolivia, Feb. 25, 1920, 319.

*Stachys debilis* H.B.K. Quito, Ecuador, Aug. 15, 1920, 894.

*Stachys Macraei* Benth. Papudo, Chile, Sept. 19, 1919, 52;  
Zapallar, Chile, Feb. 1, 1920, 306.

Originally described from Argentina, this very distinct microform has also been reported from Brazil, Chile, Ecuador, Colombia and Venezuela. It is also known from Guatemala in Central America. Pycnia are lacking and the teliospores germinate with a two celled promycelium.

263. ***Puccinia sphacelicola*** Jackson & Holway, sp. nov.

O. Pycnidiis amphigenis, gregariis, profunde insidentibus, rubro-brunneis, punctiformibus, irregulariter globoideis, 125–190  $\mu$  latis, 125–160  $\mu$  altis; periphysibus prominentibus.

I. Aecidiis hypophyllis vel costis suffultis, singulariter vel in greges 2–4 dispositis, magnis; peridio flavescenti, saccato, persistenti; cellulis peridialibus rhomboideis, leniter imbricatis, 18–25  $\times$  36–50  $\mu$ ; tunica interiore 1.5–2  $\mu$ , prominenter sed minute verrucosa, exteriore 3–5  $\mu$ , levi; aecidiosporis ellipsoideis vel globoideis, 25–30  $\times$  28–34  $\mu$ ; tunica 3–3.5  $\mu$  minute rugosa, reticulata.

III. Teleutosoris plerumque epiphyllis, sparsis vel gregariis, parvis, rotundatis, 0.3–0.5 mm. diam., castaneo-brunneis, mox nudis, pulverulentis; epidermide rupta aegre conspicua; teleutosporis late ellipsoideis, 25–29  $\times$  32–38  $\mu$ , utrinque rotundatis, septo non constrictis; tunica pallide castaneo-brunnea, 2.5–3.5  $\mu$  cr., apice incrassata 4–5  $\mu$ , minutissime crebreque verrucosa; pedicello hyalino, brevi, deciduo, saepe uno latere inserto.

*Sphacele paniculata* Benth. Riobamba, Ecuador, Aug. 10, 1920, 865 (type); Quito, Ecuador, Aug. 28, 1920, 937.

A characteristic -opsis form which seems to be distinct. The peridia are membranous, large and saccate, opening at the apex but not becoming fimbriate. The teliospore wall is slightly thickened over the pores and at the angles next the septum. The pore of the upper cell is apical. The pore in the lower cell is often in the centre with the pedicel attached at one side, or it is close to the pedicel on one side when the latter is attached at the centre of the base of the spore. The rugose-reticulate markings of the aeciospore will furnish a distinctive character.

SPECIES ON HYPTIS

264. ***Puccinia amplifica*** Jackson & Holway, sp. nov.

O. Pycnidiis non visis.

I. Aecidiis hypophyllis, in greges 1–6 dispositis, parvis, pro-

funde insidentibus, cupulatis; peridio inconspicuo, fragili, evanescenti; cellulis peridialibus laxè imbricatis prospectuque irregulariter polygoniis,  $15-18 \times 26-45 \mu$ ; tunicis tenuibus, mox collabescentibus; tunica interiore minute verrucosa; aecidiosporis ellipsoideis,  $14-16 \times 22-25 \mu$ ; tunica hyalina,  $1.5 \mu$ , crebre prominenterque verrucoso-tuberculata.

II. Uredosoris hypophyllis, sparsis, rotundatis, parvis  $0.2-0.3$  mm. diam., mox nudis, pulverulentis, pallide cinnamomeo-brunneis; epidermide rupta inconspicua; uredosporis globosis,  $18-22 \mu$  latis; tunica  $1.5 \mu$  cr., moderate minute verrucosa, poris 2 basalibus praedita.

III. Teleutosoris hypophyllis, sparsis, rotundatis,  $0.2-0.4$  mm., difformibus, aliis obscure castaneo-brunneis pulverulentisque, aliis pallide aurato-brunneis et compactis: teleutosporis difformibus, aliis conquiscentibus, late ellipsoideis,  $19-22 \times 27-33 \mu$ , utrinque rotundatis, septo leniter constrictis; tunica  $2-3 \mu$  cr. prominenter verrucosa, striis interdum longitudinalibus praedita; pedicello hyalino, brevi, deciduo; aliis germinantibus, ellipsoideis vel obovoideis,  $12-16 \times 26-30 \mu$ , supra rotundatis obtusisve, infra rotundatis angustatusve; tunica hyalina,  $1 \mu$  cr. minusve, levi, septo non vel leniter constricta; pedicello hyalino, sporam aequante vel triplo superante.

*Hyptis eriocephala* Benth. Huigra, Prov. Chimborazo, Ecuador, Aug. 2, 1920, 811; Aug. 3, 1920, 817.

This interesting species differs from *P. Gibertii* Speg. in morphological characters but exhibits a similar habit. In both species teliospores of two distinct types are present. One kind has thin colorless, smooth walls and germinates at once while the other has thick, dark colored walls with definite markings and is evidently a resting spore. Both sorts may be found in the same sorus, though it is usual to find them in separate sori. In the two collections listed above No. 811 bears mainly thick walled teliospores while in No. 817 the thin walled spores predominate.

It is species of this sort that have lead the writer to the conviction that the genus *Eriosporangium* is not an acceptable one.

265. ***Puccinia cavatica*** Jackson & Holway, sp. nov.

O. Pycnidiis non visis.

I. Aecidiis amphigenis, plerumque costis suffultis vel cauliculis, fere singulariter dispositis, magnis,  $0.5-0.75$  mm. diam., lineamento orbicularibus vel ellipsoideis, bullatis, peridio aegre visibili praeditis; peridialibus (?) inter aecidiosporas cellulis, globosis,

27–30  $\mu$  diam.; tunica 1.5–3  $\mu$  cr., crebre verrucosa; aecidiosporis globosis vel ellipsoideis, 20–22  $\times$  20–24  $\mu$ ; tunica hyalina, 1.5–2  $\mu$ , crasse verrucosa.

III. Teleutosoris hypophyllis, sparsis, parvis, rotundatis, 0.2–0.4 mm. diam., mox nudis, compactis, pulvinatis, primum pallide cinnamomeo-brunneis, dein e germinatione cinereis; epidermide rupta non conspicua; teleutosporis, cylindraceis, fusoideis vel lanceolato-oblongis, 14–21  $\times$  54–75  $\mu$ , supra obtusis, infra plerumque attenuatis sed rotundatis; cellula superiore plerumque altera latiore, et fere fortiter constricta; tunica tenui 1  $\mu$  minusve, levi, pallide cinnamomeo-brunnea; pedicello hyalino, sporam aequante vel brevior.

*Hyptis carpinifolia* Benth. Bello Horizonte, Minas Geraes, Brazil, Nov. 22, 1921, 1325.

No urediniospores could be found and the species may be an -opsis form. The species does not agree with *P. Hyptidis*. It is possible that *Uredo Hammari* P. Henn., which Sydow (Monog. Ured. 4: 566, 1924) says is an aecidium, may be the same. No material has been available for comparison.

The aecia are characteristic, large and deep seated, and protected by a prominent over-arched growth of the epidermis.

266. PUCCINIA DISTORTA Holway, Ann. Myc. 3: 22. 1905.

*Hyptis* sp. (near *H. arborea* Benth.) Hacienda La Florida, Sur Yungas, Bolivia, May 26, 1920, 652.

This distinct micro-form is new to the South American flora having been previously reported only from the southern United States and Mexico.

267. PUCCINIA HYPTIDIS (M. A. Curtis) Tracy & Earle, Bull. Miss. Exp. Sta. 34: 86. 1895.

*Uredo Hyptidis* M. A. Curtis, Am. Jour. Sci. II. 6: 353. 1848.  
*Eriosporangium Hyptidis* Arth. N. Am. Fl. 7: 211. 1912.

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*Hyptis canescens* Benth. Hacienda La Florida, Sur Yungas, Bolivia, May 26, 1920, 660; Villa Aspiazu, Sur Yungas, Bolivia, May 30, 1920, 683.

This species has been previously reported in South America from British Guiana, Trinidad and Colombia. A doubtful report by Dietel from Brazil may prove to be another species.

268. *PUCCINIA HYPTIDIS-MUTABILIS* Mayor, Mém. Soc. Neuch. Sci. Nat. 5: 496. 1913.

*Eriosporangium Hyptidis-mutabilis* Sydow, Ann. Myc. 20: 122. 1922.

*Hyptis dubia* Pohl. Reserva Florestal, São Paulo, Brazil, May 10, 1922, 1838.

*Hyptis pectinata* Poit. Petropolis, Rio de Janeiro, Brazil. Nov. 6, 1921, 1284; Petropolis, Rio de Janeiro, Brazil. Dec. 29, 1921, 1435.

*Hyptis suaveolens* (L.) Poit. Portovelo, Prov. del Oro, Ecuador, Sept. 22, 1920, 999; Campinas, São Paulo, Brazil, April 4, 1922, 1699.

*Hyptis umbrosa* Selzm. Friburgo, Rio de Janeiro, Brazil. Jan. 3, 1922, 1448.

*Hyptis* sp. Ouro Preto, Minas Geraes, Brazil, Dec. 6, 1921, 1368; Friburgo, Rio de Janeiro, Brazil, Jan. 4, 1922, 1455.

Originally described from Colombia, this species has been reported elsewhere in South America only from Trinidad. It is also known from Costa Rica.

269. *Puccinia perfuncta* Jackson & Holway, sp. nov.

O. Pycnidiis non visis.

I. Aecidiis plerumque epiphyllis, saepe costis suffultis et cauliculis, in gregibus 1-6 maculis decoloratis vel numerosioribus nervis caulibusve insidentibus, parvis, cupulatis, peridio aegre conspicuo fragili evanescenti praeditis; cellulis peridialibus laxè imbricatis; tunica intus extusque tenui, collabescente, interiore minute verrucosa; aecidiosporis parum irregulariter ellipsoideis,  $18-21 \times 24-30 \mu$ ; tunica hyalina,  $1.5-2 \mu$ , crasse tuberculata.

II. Uredosoris hypophyllis, sparsis, rotundatis 0.2-0.4 mm. diam., mox nudis, pulverulentis, aurato-brunneis; epidermide fissa non conspicua; uredosporis globosis,  $18-21 \mu$ ; tunica tenui, hyalina, vel leniter aurato-brunnescenti, minute crebreque verrucosa, poris obscuris praedita.

III. Teleutosoris hypophyllis, sparsis, rotundatis, 0.2-0.4 mm. diam., compactis, pulvinatis, primum flavescentibus, dein e germinatione cinereis; teleutosporis ellipsoideis,  $15-21 \times 30-36 \mu$ , supra rotundatis, infra rotundatis vel parum attenuatis, septo leniter constrictis; tunica uniformiter tenui,  $1-1.5 \mu$ , levi, pedicello hyalino brevi deciduo instructa.

*Hyptis fasciculata* Benth. Therezopolis, Rio de Janeiro, Brazil, October 11, 1921, 1211; Juquery, São Paulo, Brazil, Feb. 2, 1922, 1527 (type); Santa Amaro, São Paulo, Brazil, June 26, 1922, 1983.

*Hyptis pectinata* (L.) Poit. Huigra, Ecuador, Aug. 6, 1920, 849.

*Hyptis* sp. Petropolis, Rio de Janeiro, Brazil, Nov. 4, 1921, 1277.

While the teliospores resemble those of *P. medellinensis* Mayor, the urediniospores and aeciospores are quite different. The species is quite distinct from *P. tucumanensis* (Speg.) Arth., with which it has been compared.

The specimen on *Hyptis pectinata* is included here tentatively. The collection is fragmentary and consists of telia with a few urediniospores. The spores are somewhat larger than in *P. perfuncta*. It has been compared with *P. parilis* Arth., but does not agree well with that species. It may possibly be undescribed.

270. ***Puccinia perscita*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, profunde insidentibus, paucis, in maculis leniter hypertrophicis dense confertis, punctiformibus, ellipsoideis,  $90-120 \times 120-140 \mu$ , nigricantibus; periphysibus visibilibus.

I. Aecidiis epiphyllis, in greges parvos 3-6 aggregatis, purpurascens maculis circa pycnidia insidentibus, parvis, rotundatis, peridio visibili membranaceo saepe longo cylindraceo albo praeditis; cellulis peridialibus prospectu visis irregulariter polygoniis,  $18-21 \times 30-45 \mu$ ; tunica exteriori tenui  $1 \mu$  minusve, mox collabescente, levi, interiore  $3.5-5 \mu$  prominenter crebreque verrucoso-rugosa; aecidiosporis ellipsoideis,  $16-21 \times 25-31 \mu$ ; tunica hyalina,  $1.5-2 \mu$ , in extremo usque  $3-4.5 \mu$  incrassata, prominenter verrucosa, praesertim in extremo incrassato.

III. Teleutosoris hypophyllis, sparsis, rotundatis, parvis,  $0.2-0.3$  mm. diam., mox nudis, compactis, primum pallide castaneo-brunneis, deinde e germinatione cinereis; epidermide rupta inconspicua; teleutosporis ellipsoideis, oblongis vel obovatis,  $18-21 \times 44-56 \mu$ , supra rotundatis obtusisve, infra rotundatis angustatisve, plerumque septo fortiter constrictis; tunica infra subhyalina, supra pallide castaneo-brunnea, tenui  $1 \mu$ , lateribus pori apiceque et poro loculi inferioris prope septum usque  $2-2.5 \mu$  paulatim incrassata, levi; pedicello hyalino, sporam aequante vel brevior.



*Hyptis odorata* Benth. Hacienda La Florida, Sur Yungas, Bolivia, May 28, 1920, 669 (type); Villa Aspiazu, Sur Yungas, Bolivia, May 30, 1920, 684.

Apparently a distinct species, characterized by the small epiphyllous aecia with strongly developed peridium and the teliospores slightly thickened at the sides of the germ pores. It may possibly be an -opsis form as no uredinia were observed.

271. ***Uredo amphiospora*** Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis vel gregariis, saepe confluentibus, rotundatis, 0.2–0.5 mm. diam., cinnamomeo- vel castaneo-brunneis, mox nudis, pulverulentis, epidermide rupta cinctis; uredosporis difformibus, aliis normalibus, depresso globosis, 17–19  $\mu$  altis, 21–24  $\mu$  latis, lateraliter visis, sed globosis extremo visis; tunica 1–1.5  $\mu$  cr., cinnamomeo-brunnea, crebre minuteque echinulata; poris 2, aequatorialibus, longo axe insidentibus; sed aliis amphiosporis (?), ellipsoideis vel oblongis, poris lateraliter visis, 21–26  $\times$  27–30  $\mu$ ; tunica castaneo-brunnea, 3–4  $\mu$  cr., apparenter levi sed obscure echinulata, poris 2 aequatorialibus praedita.

*Hyptis spicata* Poit. Sorata, Bolivia, April 21, 1920, 560; Cochabamba, Bolivia, Feb. 25, 1920, 324 (type); March 5, 1920, 369.

This very distinct uredo-form has two very different types of spores which may occur in the same or separate sori. The thick walled spores may be interpreted as amphiospores. These are slightly compressed laterally, often appearing nearly globoid when pores are in face view. The normal uredinospores are flattened laterally and vertically, with the pores on the long axis and appear ellipsoid in side view and globoid in face view.

ON THE GENUS *SALVIA*

272. ***Puccinia aenigmatica*** Jackson & Holway, sp. nov.

II. Uredosoris amphigenis, sparsis, rotundatis, parvis, 0.2–0.4 mm. diam., mox nudis, pulverulentis, cinnamomeo-brunneis, epidermide rupta cinctis; uredosporis depresso globosis, 19–23  $\mu$  altis, 25–30  $\mu$  latis; tunica tenui, 1–1.5  $\mu$ , cinnamomeo-brunnea, crebre minuteque verrucosa, poris 2, hilo approximatis.

III. Teleutosoris amphigenis, rotundatis, 0.3–0.6 mm. diam., nigricantibus, compactis, dein pulverulentis, epidermide fissa

cinctis; teleutosporis globosis vel late ellipsoideis,  $31-35 \times 36-42 \mu$ , utrinque rotundatis, non constrictis; tunica castaneo-brunnea,  $4-6 \mu$  cr., apice incrassata ad  $6-9 \mu$ , crasse aequaliter verrucosa; pedicello hyalino, persistenti sed collabescente, sporam duplo vel triplo aequante.

*Salvia Kuntzeana* Briq. Cochabamba, Bolivia, March 1, 1920, 358.

Somewhat resembling *P. gentilis* Arth. and *P. porphyretica* Jackson & Holway. It differs from the former in the broader regular teliospores and the broader more finely marked uredinio-spores. From the latter it differs in the thin walled uredinio-spores which are depressed globoid.

273. ***Puccinia albicera*** Jackson & Holway, sp. nov.

*Puccinia aequatoriensis* Lagerh. ined. (not Sydow 1903).

O. Pycnidiis epiphyllis, paucis, aecidiis immixtis, punctiformibus, primum brunneis deinde nigricantibus, profunde insidentibus,  $110-150 \mu$  latis,  $150-175 \mu$  altis; periphysibus brevibus.

I. Aecidiis epiphyllis, paucis, in greges 3-6 in areis leniter hypertrophicis aggregatis, cupulatis, peridio non prominenti praeditis, mox findendo unicellularibus, epidermide rupta cinctis; cellulis peridialibus, prospectu visis, irregulariter rhomboideis,  $24 \times 45 \mu$ ; tunica minutissime verrucosa sed apparenter levi; aecidiosporis angulato-ellipsoideis,  $18-24 \times 24-36 \mu$ ; tunica tenui,  $1-1.5 \mu$ , crasse verrucoso-tuberculata.

II. Uredosoris hypophyllis, sparsis vel gregariis, mox nudis, cinnamomeo-brunneis, pulverulentis; epidermide fissa inconspicua; uredosporis globosis,  $21-26 \mu$ ; tunica tenui  $1-1.5 \mu$ , cinnamomeo-brunnea, crebre minute echinulata; poris parum obscuris, 1 2, subaequatorialibus.

III. Teleutosoris hypophyllis, sparsis vel gregariis, primum pallide castaneo-brunneis, deinde e germinatione cinereis, pulverulentis; epidermide rupta non visibili; teleutosporis ellipsoideis, oblongis vel clavatis,  $16-19 \times 44-62 \mu$ , infra rotundatis attenuatisve, supra rotundatis obtusisve, plerumque septo prominenter constrictis; tunica cinnamomeo-brunnea, tenui  $1 \mu$  minusve, apice palliore area incrassata,  $35-36 \mu$ , levi; pedicello hyalino, sporam aequante vel brevior.

*Salvia derasa* Benth. Quito, Ecuador, Aug. 14, 1920, 889.

*Salvia tortuosa* H.B.K. Quito, Ecuador, Aug. 21, 1920, 930.

Very distinct from other eu-forms on *Salvia* on account of the thin smooth walled teliospores germinating at once.

274. *Puccinia astricta* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, prominentibus, paucis, in greges 2-6 aggregatis, maculis flavescentibus vel purpurascentibus insertis, profunde insidentibus, connoideis vel piriformibus, circiter  $125 \times 125 \mu$ .

III. Teleutosoris hypophyllis, pycnidiis gregatim contrappositis, cinnamomeo-brunneis, compactis, dein pulvinatis, e germinatione cinereis; epidermide rupta inconspicua; teleutosporis cylindraceis,  $22-28 \times 65-90 \mu$ , infra rotundatis vel truncatis, supra plerumque angustatulis, septo saepe prominenter constrictis; tunica tenui,  $1-1.5 \mu$ , apice non conspicue incrassata, levi; pedicello hyalino, forti, apice  $20-25 \mu$  lato, duplo vel triplo sporam aequante, mox collabescente.

*Salvia* sp. Huigra, Prov. Chimborazo, Ecuador, Aug. 4, 1920, 842A.

A very distinct micro-form, with large thin walled teliospores which germinate at once with a four celled promycelium.\* The apex of the teliospore is not thickened except very slightly at the sides of the pore. The pedicel is unusually thick and stout.

275. *PUCCINIA CONSPERSA* Dietel, Hedwigia 36: 30. 1897.

? *Puccinia uliginosa* Speg. Anal. Mus. Nac. Hist. Nat. Buenos Aires, 23: 26. 1912.

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*Salvia arenaria* St. Hil. Campos do Jordão, São Paulo, Brazil, May 2, 1922, 1802.

*Salvia Sellowiana* Benth. Reserva Florestal, São Paulo, Brazil, May 16, 1922, 1806.

*Salvia splendens* Sellow, Sylvestre, Rio de Janeiro, Aug. 15, 1921, 1039.

*Salvia* sp. Rio de Janeiro, Brazil, Nov. 13, 1921, 1300; Petropolis, Rio de Janeiro, Nov. 8, 1921, 1285; São João, São Paulo, Brazil, July 2, 1922, 1993.

This species was described as having aecia and telia only. All our specimens show uredinia or urediniospores in the telia. *Puccinia uliginosa* Speg. was described with uredinia and later with aecia. Our material fits the measurements and description of both species very well, though no previous collections have been seen. *P. conspersa* was originally collected at Serra Geral,

Brazil. In some collections careful examination shows that the spores are minutely and very inconspicuously verrucose above.

276. *Puccinia conturbata* Jackson & Holway, sp. nov.

II. Uredosoris hypochyltis, sparsis vel gregariis, parvis, 0.2–0.4 mm. diam., mox nudis, cinnamomeo-brunneis, pulverulentis; epidermide rupta inconspicua; uredosporis globosis vel oblato-sphaeroideis, 22–25  $\mu$  diam., tunica 1.5–2  $\mu$  cinnamomeo-brunnea moderate minuteque echinulata praeditis; poris 2, subaequatorialibus.

III. Teleutosoris uredosoris conformibus, castaneo-brunneis; teleutosporis ellipsoideis vel oblongis, 23–26  $\times$  31–36  $\mu$ , utrinque rotundatis, septo leniter vel haud constrictis; tunica castaneo-brunnea, 1.5–2.5  $\mu$  cr., apice subcrasso praedita, 4–6  $\mu$ , prominenter verrucoso-rugosa; pedicello hyalino, brevi, deciduo.

*Salvia quitensis* Benth. Cuenca, Ecuador, Sept. 15, 1920, 992.

*Salvia* sp. Huigra, Prov. Chimborazo, Ecuador, Aug. 4, 1920, 842 (type).

This species differs from *P. infrequens* Holway in that the teliospore wall is thicker and the markings more prominent, and from *P. farenacea* Long in the character of the markings of the teliospores. The first specimen listed above is on a different host from the type and shows only urediniospores. These are small and have two subequatorial pores but may belong to a different species.

277. *PUCCINIA GILLIESI* Speg. Anal. Soc. Ci. Argent. 47: 265. 1899.

*Puccinia obesa* Sydow, Monog. Ured. 2: 298. 1902.

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*Salvia Bangii* Rusby, Between Oruro and Cochabamba, Bolivia, Feb. 23, 1920, 314.

We follow Sydow (Monog. Ured. 2: 876. 1903) in listing *P. obesa* as a synonym of *P. Gilliesi*. The latter was described from teliospores only. The collection listed above bears uredinia and telia. The urediniospores agree well with Sydow's description, as do the teliospores except that they are slightly thickened over the pores. The pore of the lower cell is quite uniformly situated halfway between pedicel and septum. The teliospore wall is about 7.5  $\mu$  in thickness, thickened to 10  $\mu$  over the pores.

278. *PUCCINIA IMPEDITA* Mains & Holway; Arth. Mycologia 10: 135. 1918.

*Bullaria impedita* Arth. & Mains, N. Am. Fl. 7: 493. 1922.

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*Salvia tiliaefolia* Vahl. Hacienda Anacuri, Nor Yungas, Bolivia, June 2, 1920, 700; Hacienda La Florida, Sur Yungas, Bolivia, May 29, 1920, 675.

The collections listed above are assigned to this brachy-form somewhat tentatively. The urediniospores are depressed globoid with two equatorial pores. The teliospores are somewhat lighter in color than specimens of this species which we have examined from Costa Rica. Pycnia were not seen. *P. impedita* is known in Central America and the West Indies. It has been reported on the above listed host from Mexico and Costa Rica. The only previous report from South America is from Trinidad.

279. *PUCCINIA MITRATA* Sydow, Monog. Ured. 2: 294. 1902.

*Salvia erythradena* Briq. Cochabamba, Bolivia, March 10, 1920, 386.

This species does not appear to have been previously listed from South America. It was originally described from Mexico and is also known from Guatemala. It is characterized by the large teliospores having conspicuously verrucose walls considerably thickened above, and by the rather small urediniospores.

280. *Puccinia porphryretica* Jackson & Holway, sp. nov.

II. Uredosoris amphigenis, plerumque epiphyllis, sparsis vel gregariis, in maculis flavescentibus subpurpureisve insidentibus, magnis, rotundatis, 1.0–1.75 mm. diam., cinnamomeo-brunneis, tardius nudis, pulverulentis, epidermide rupta cinctis; uredosporis late ellipsoideis vel obvoideis, 21–25 × 25–28  $\mu$ ; tunica cinnamomeo-brunnea, 2.5–3  $\mu$  cr., moderate minuteque echinulata; poris 2, aequatorialibus.

III. Teleutosoris uredosoris conformibus, brunneo-nigricantibus, pulverulentis; teleutosporis globosis vel latissime ellipsoideis, 32–38 × 36–44  $\mu$ , utrinque rotundatis, septo non constrictis; tunica castaneo-brunnea, 5–6  $\mu$  cr., apice incrassata ad 8–10  $\mu$ , prominenter aequaliterque verrucoso-rugosa; pedicello hyalino, rigido, in parte inserta 7–9  $\mu$  lato, infra angustato, duplo vel triplo sporam aequante.

*Salvia Cridgesii* Britton, Cochabamba, Bolivia, Feb. 26, 1920, 329.

*Salvia pseudoavicularis* Briq. Sorata, Bolivia, Apr. 15, 1920, 527.

*Salvia* sp. Hacienda del Urco, Urubamba Valley, Cuzco, Peru, July 4, 1920, 761 (type).

Collection 761, the last one listed, bears telia, the other two bear uredinia. The species is somewhat like *P. gentilis* Arth. from Mexico, but differs in several respects. The sori are much larger in our species and the urediniospore walls are thicker with the markings less prominent. The teliospores are broader, less irregular, and the markings more prominent with a greater tendency to be rugose.

281. *PUCCINIA ROESTELIIFORMIS* Lagerh.; Sydow, Monog. Ured. 2: 292. 1902.

*Salvia corrugata* Vahl. Biblian, Prov. de Cañar, Ecuador, Sept. 9, 1920, 966.

This very characteristic species has usually been considered an -opsis form. Our specimen, however, bears uredinia. These are abundant and accompanied by colorless, thin walled, clavate paraphyses up to  $125\ \mu$  long and with the apex  $16\text{--}26\ \mu$  broad. The urediniospores are very characteristic. They are globoid,  $25\text{--}29\ \mu$  in diameter. The wall is golden brown  $1\text{--}1.5\ \mu$  thick, finely verrucose, with about 8 scattered pores.

The wall of the aeciospore in this species is beautifully reticulate, a character which does not seem to have been noted.

282. *Puccinia sana* Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis, parvis, rotundatis,  $0.2\text{--}0.4$  mm. diam., mox nudis, cinnamomeo-brunneis, pulverulentis, epidermide rupta cinctis; uredosporis globosis,  $22\text{--}25\ \mu$  latis; tunica cinnamomeo-brunnea,  $1\text{--}1.5\ \mu$  cr., moderate minuteque echinulata, poro singulo laterali praedita.

III. Teleutosoris uredosoris conformibus, castaneo-brunneis, pulverulentis; teleutosporis late ellipsoideis, saepe parum irregularibus,  $21\text{--}25 \times 26\text{--}32\ \mu$ , utrinque rotundatis, plerumque non constrictis; tunica castaneo-brunnea,  $1.5\text{--}2\ \mu$  cr., apice et septo supra porum loculi inferioris ad  $3\text{--}4\ \mu$  leniter incrassata, minute crebreque verrucoso-rugosa; pedicello hyalino, brevi, fragili.

*Salvia leucocephala* H.B.K. Huigra, Chimborazo, Ecuador, Aug. 4, 1920, 835, 839.

A distinct species somewhat resembling *P. paramensis* Mayor but differing in the larger more prominently marked teliospores and in urediniospore characters. It is very much the same as an undescribed collection from Chimborazo, Ecuador, marked *P. andicola* Lagerh., which is in the New York Botanical Garden herbarium. A few aecia too old for description are present, indicating that the species is an eu-form.

#### SPECIES ON SOLANACEAE

283. *Aecidium mundulum* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis vel cauliculis, per arias infectas dense dispersis, punctiformibus, aurato-brunneis, globosis vel ellipsoideis,  $120-125 \times 120-135 \mu$ ; periphysibus prominentibus,  $100 \mu$  vel longioribus.

I. Aecidiis hypophyllis vel cauliculis, ex mycelio late disperso aequaliter sparsis, cupulatis, peridio eroso non prominenti instructis; cellulis peridialibus rhomboideis, subforte imbricatis,  $11-13 \times 24-28 \mu$ ; pariete exteriori  $2-3 \mu$  cr., levi, interiore  $1-2 \mu$  cr., minute verrucoso; aecidiosporis ellipsoideis  $18-21 \times 25-31 \mu$ , tunica tenui  $1 \mu$  minute crebreque verrucosa praeditis.

*Solanum pulchellum* Phil. Zapallar, Chile, Sept. 22, 1919, 63.

284. *Aecidium papudense* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis sed quandoque hypophyllis, in maculis flavescentibus dense confertis, punctiformibus, profunde insidentibus, subflavis, globoideis,  $110-128 \mu$  latis; periphysibus prominentibus.

I. Aecidiis hypophyllis, in maculis flavescentibus aggregatis, magnis, cupulatis, bullatis, peridio subflavo eroso instructis; cellulis peridialibus laxae adhaerentibus, rhomboideis, parum imbricatis,  $13-19 \times 35-40 \mu$ ; pariete exteriori  $5-6 \mu$ , transverse striato, interiore  $1.5-2 \mu$ , minute verrucoso; aecidiosporis globosis vel ellipsoideis,  $21-25 \times 24-30 \mu$ ; tunica hyalina vel pallidissime aurato-brunnea,  $2 \mu$  cr., tenuiter verrucosa.

*Solanum runcinatum* R. & P. Papudo, Chile, Sept. 18, 1919, 38.

This aecidium differs notably from the preceding. The infection is local, producing spots. The aecia are somewhat

larger with more prominent peridium. The aeciospores, while about the same size, have much thicker walls.

285. **Aecidium Poecilochromae** Jackson & Holway, sp. nov.

O. Pycnidiis amphigenis, in greges parvos crebre confertis, aecidiis circumdatis, punctiformibus, parvis, flavo-aureis, depresso globosis, 60–75  $\mu$  altis, 85–90  $\mu$  latis; periphysibus prominentibus.

I. Aecidiis hypophyllis, in greges 4–8 mm. diam. aggregatis, maculis flavescentibus insitis, saepe concentric dispositis, peridio prominente erecto breviter cylindraceo praeditis; cellulis peridialibus rectangulis, leniter imbricatis, 17–20  $\times$  25–32  $\mu$ ; pariete exteriori 7–9  $\mu$  cr., transverse striato, interiori 2–3  $\mu$ , minute crebreque verrucoso; aecidiosporis globosis vel late ellipsoideis, 19–25  $\times$  25–32  $\mu$ ; tunica hyalina, 1–1.5  $\mu$ , minute crebreque verrucosa, apparenter prope tereti.

*Poecilochroma quitensis* Meirs.? Cochabamba, Bolivia, March 3, 1920, 363 (type), March 10, 1920, 388.

286. **Endophyllum Holwayi** Jackson, sp. nov.

O. Pycnidiis plerumque epiphyllis, quandoque amphigenis, crebre gregariis, gregatim teleutosoris contrappositis, subepidermicis, globosis vel oblato-sphaeroideis, 90–105  $\mu$  latis, 75–90  $\mu$  altis; periphysibus fasciculatis, prominentibus, 45–60  $\mu$  altis.

III. Teleutosoris aecidiiformibus, hypophyllis, crebre gregariis, in greges 1–4 mm. diam. dispositis, cupulatis; peridio visibili, firmo, albido, margine eroso vel revoluto instructo; cellulis peridialibus rhomboideis lateraliter visis, 9–13  $\times$  30–38  $\mu$ , leniter imbricatis; pariete exteriori, tereti, 3–4  $\mu$  cr., interiori 2–2.5  $\mu$ , minute crebreque verrucoso; soris teleutosporiferis castaneo-brunneis; teleutosporis catenulatis, parum irregulariter ellipsoideis vel oblongis, 16–21  $\times$  28–40  $\mu$ ; tunica cinnamomeo-usque castaneo-brunnea, 2.5–3.5  $\mu$  cr., apice saepe leniter crassiore, 4–4.5  $\mu$ , praecipue apice minute verrucosa, poro singulo visibili apicali praedita; basidio germinando 4-cellulari; basidiosporis ellipsoideis, 8–10  $\times$  12–16  $\mu$ .

*Salpichroa* sp. Sorata, Bolivia, Apr. 29, 1920, 582 (type); May 7, 1920, 592.

This remarkable rust is assigned tentatively to *Endophyllum*. While the gross appearance is that of an *Aecidium*, the spore mass is chestnut-brown. The remarkable feature of the species is the thick walled teliospores having a single apical pore. These spores appear like *Uromyces* spores without a pedicel. They are



borne in chains and intercalary cells may be demonstrated between the young spores though these are not conspicuous. There is some slight tendency to lateral adherence of the spores but no columns are formed which extend above the surface of the leaf. The spores occasionally collect in masses and when this is the case may be found germinating. The unopened sori appear very much like those of *Dietelia*.

287. *CHRYSOCYCLUS CESTRI* (Dietel & P. Henn.) Sydow, Ann. Myc. **23**: 322. Dec. 31, 1925.

*Puccinia Cestri* Dietel & P. Henn. Hedwigia **41**: 295. 1902.

*Chrysopsora Cestri* Arth. Bull. Torrey Club **51**: 53. 1924.

*Puccinia magnifica* Lagerh. ined.

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*Cestrum strigillatum* R. & P. Hacienda La Florida, Sur Yungas, Bolivia, May 26, 1920, 653.

*Cestrum* sp. Therezopolis, Estado do Rio, Brazil, Oct. 1, 1921, 1181; Reserva Florestal, Brazil, May 13, 1922, 1846; Tremembé, São Paulo, Brazil, May 30, 1922, 1907.

The first collection of this interesting species of which we have any knowledge was made by Lagerheim, June 1891, at Pichencha, Ecuador. This collection is marked *Puccinia magnifica* Lagerh., but the name seems never to have been published.

In 1924 Arthur transferred the species to *Chrysopsora*. During the year 1925, the writer made a study of this species together with *C. Mikaniae* Arth., and came to the conclusion that Arthur had misinterpreted their morphology. A preliminary note was published (Mycologia **18**: 48-49. Jan. 1, 1926) in which the genus *Holwayella* was proposed, with *C. Mikaniae* as the type, to accommodate these two species. Almost simultaneously, but technically one day previously, Sydow published the genus *Chrysocyclus* with the above species as the type.

The genus is in effect a micro-*Puccinia* in which the sori are waxy and there is no cessation of development between the formation of the spore initial and the time when the basidiospores are developed.

The type collection was made in Brazil and the species has been otherwise previously reported from Panama and Costa Rica.

288. *DIDYMOPSIS SOLANI-ARGENTEI* (P. Henn.) Dietel, *Hedwigia* 38: 254. 1899.

*Accidium Solani-argentei* P. Henn. *Hedwigia* 35: 260. 1896.

*Solanum Swartzianum* R. & S. Therezopolis, Rio de Janeiro, Brazil, Sept. 28, 1921, 1160.

*Solanum* sp. Tremembé, São Paulo, Brazil, May 30, 1922, 1912.

This very characteristic species has been previously reported only from Brazil. Careful examination fails to reveal any evidence of a peridium. Each two celled spore is separated by a large, short, cylindrical intercalary cell, which may be 14–20  $\mu$  high by 16–18  $\mu$  wide. The spores germinate by a four-celled promycelium. The basidiospores are obovate, 9–12 by 14–16  $\mu$ .

289. *PUCCINIA ACNISTI* Arth. Bot. Gaz. 65: 470. 1918.

*Puccinia Nicotianae* Arth. Bot. Gaz. 65: 470. 1918.

*Acnistus* sp. El Chaco, Sur Yungas, Bolivia, May 25, 1920, 651; Hacienda la Florida, Sur Yungas, Bolivia, May 27, 1920, 667.

The two collections listed above bear aecia only and occur on different species of *Acnistus*. They seem to belong with this -opsis form, which was first described as on *Acnistus arborescens* Schlecht. from Santa Clara, Peru (Rose 18722a). The type host has since been identified as *A. aggregatus* (R. & P.) Miers. *Puccinia Nicotianae* was described at the same time as on *Nicotiana tomentosa* R. & P. This host has since been found to be *Acnistus aggregatus* also. The species is known from Trinidad and Costa Rica in the aecial stage.

290. *PUCCINIA ARAUCANA* Dietel & Neger, in Engl. Bot. Jahrb. 24: 159. 1897.

*Solanum cyrtopodium* Dun. Recinto, Chile, Jan. 10, 1920, 284.

*Solanum lycioides* L. Cochabamba, Bolivia, March 7, 1920, 378; LaPaz, Bolivia, March 19, 1920, 422.

*Solanum* sp. La Falda, Argentina, Aug. 24, 1922, 2049.

The first specimen listed above is on the same host species as

the type collection which was also made in Chile. The species, which appears to be an -opsis form, has not been previously reported elsewhere than in Chile. A collection made at Valdivia, Chile (Philippi No. 35) and reported by Winter as *P. pampeana* Speg. is probably the same.

291. *Puccinia aulica* Jackson & Holway, sp. nov.

O. Pycnidiis non visis, probaliter carentibus.

III. Teleutosoris hypophyllis cauliculisque, dense gregariis, aliis foliiculis in areas subhypertrophicas 1–2 mm. diam. confluentibus, sed aliis cauliculis latius dispositis, quandoque omnibus in contextibus novis dispositis, parvis, rotundatis, 0.2–0.5 mm. diam., mox nudis, pulvinatis, obscure castaneo-brunneis, epidermide rupta non visibili circumdatis; teleutosporis late ellipsoideis, 19–25 × 26–35  $\mu$ , utrinque rotundatis, non constrictis; tunica obscure cinnamomeo-brunnea, 1–1.5  $\mu$  cr., apice paulatim incrassata usque 5  $\mu$ , levi; pedicello hyalino, fragili, variabili, saepe deciduo, duplo ad triplum sporam aequante.

*Solanum montanum* L. Quito, Ecuador, Aug. 13, 1920, 875 (type).

292. *PUCCINIA IMITANS* Sydow, Monog. Ured. 1: 273. 1902.

*Solanum utile* Klotzsch, Quito, Ecuador, Aug. 19, 1920, 896.

This species was described from material collected by Lagerheim in the same locality from which the specimen listed above was obtained. The type collection is apparently the one reported as *P. Solani* Schw. by Patouillard and Lagerheim (Bull. Soc. Myc. Fr. 11: 215. 1915).

293. *PUCCINIA NEGERIANA* Dietel, in Engl. Bot. Jahrb. 22: 351. 1896.

*Solanum* sp. La Falda, Argentina, Aug. 24, 1922, 2048.

The collection listed above appears to fit *P. Negeriana* better than any of the other micro-forms described on *Solanum*. Mesospores are abundant. The species has presumably been reported only from Chile.

294. *PUCCINIA SARACHAE* Mayor, Mém. Soc. Neuch. Sci. Nat. 5: 499. 1913.

*Saracha biflora* R. & P. Sorata, Bolivia, Apr. 19, 1920, 554.

Originally described from Colombia, this micro-form has also been collected in Costa Rica.

295. PUCCINIA SOLANINA Speg. Anal. Mus. Nac. Hist. Nat. Buenos Aires **23**: 26. 1912.

*Aecidium solaninum* Speg. Anal. Soc. Ci. Argent. 12: 79. 1881.

*Aecidium solaninum* var. *laevis* Speg. Anal. Mus. Nac. Hist. Nat. Buenos Aires **19**: 322. 1909.

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*Acnistus* sp. Huigra, Prov. Chimborazo, Ecuador, Aug. 8, 1920, 858.

This collection consists of aecia and associated telia and is evidently an -opsis form. The aecia are systemic. The teliospores are described as smooth, but are minutely verrucose. Otherwise the material fits the description admirably.

296. PUCCINIA SOLANI-TRISTIS P. Henn. Hedwigia **35**: 236. 1896.

*Solanum Neves-Armondii* Dusén, Reserva Florestal, Itatiaya, Brazil, May 7, 1922, 1820.

*Solanum rufescens* Sendt. Therezopolis, Rio de Janeiro, Brazil, Oct. 9, 1921, 1205.

*Solanum* sp. Therezopolis, Rio de Janeiro, Brazil, Oct. 9, 1921, 1203; Petropolis, Rio de Janeiro, Brazil, Oct. 18, 1921, 1231; Campinas, São Paulo, Brazil, Apr. 2, 1922, 1686; Reserva Florestal, Itatiaya, Brazil, May 9, 1922, 1835.

297. PUCCINIA TUBULOSA (Pat. & Gaill.) Arth. Am. Jour. Bot. **5**: 464. 1918.

*Aecidium tubulosum* Pat. & Gaill. Bull. Soc. Myc. France **4**: 97. 1888.

*Aecidium Uleanum* Paz. Hedwigia **31**: 95. 1892.

*Aecidium solanophilum* Speg. Ann. Mus. Nac. Buenos Aires **23**: 34. 1912.

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*Solanum subscandens* Vell. São Paulo, Brazil, Jan. 23, 1922, 1495.

*Solanum torvum* Sw. Ribeirão Pires, São Paulo, Brazil, March 25, 1922, 1680.

*Solanum* sp. Barbacena, Minas Geraes, Brazil, Dec. 13, 1921, 1391; São João, São Paulo, Brazil, Apr. 13, 1922, 1728; Villa Prudente, São Paulo, Brazil, May 31, 1922, 1922.

This heteroecious species with uredinia and telia on *Paspalum* and other grasses is listed here to make the record of solanaceous rusts complete. The species is considered in detail by Arthur in his report on the grass rusts of the Holway collections (Proc. Am. Phil. Soc. 64: 173-176. 1925).

298. **Pucciniosira Holwayi** Jackson, sp. nov.

O. Pycnidiis epiphyllis, numerosis, punctiformibus, profunde insidentibus, crebre gregariis, in maculis decoloratis positus, globosis vel depresso globosis, 90-150  $\mu$  altis, 120-150  $\mu$  latis; periphysibus carentibus.

III. Teleutosoris hypophyllis, numerosis, in greges orbiculares 1.5-4 mm. diam. insidentibus, breviter cylindraceis; peridio membranaceo, columnae sporarum firme adhaerente; teleutosporis bicellularibus, parum irregulariter ellipsoideis, 16-24  $\times$  36-48  $\mu$ , apice saepe acuto instructis, septo, saepe obliquo, non constrictis; tunica e hyalina flavescenti, plerumque uniformiter tenui, 1-1.5  $\mu$ , sed quandoque una vel utraque fine incrassata usque 5  $\mu$ ; cellulis intercalaribus conspicuis.

*Solanum laxiflorum* Sendt. Petropolis, Rio de Janeiro, Brazil, Dec. 29, 1921, 1434.

The species is somewhat like *P. Solani* Lagerh. but differs primarily in that the teliospore wall is only slightly or not at all thickened. When the wall is thicker, the thickened portion is confined to opposite ends of the two-celled spore. In *P. Solani* the thickening is much greater and occurs at the apex of both cells of the two-celled spores.

299. **UROMYCES CESTRI** (Mont.) Lév. Ann. Sci. Nat. III. 8: 371. 1847.

*Aecidium Cestri* Mont. Ann. Sci. Nat. II. 3: 356. 1835.

*Uredo Cestri* Bert.; Mont. Ann. Sci. Nat. II. 3: 356. 1835.

*Pucciniola Cestri* Arth. N. Am. Fl. 7: 452. 1921.

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*Cestrum auriculatum* L'Hér. Sorata, Bolivia, Apr. 14, 1920, 524; Cochabamba, Bolivia, Feb. 25, 1920, 317.

*Cestrum Parqui* L'Hér. Panimavida, Chile, Dec. 10, 1919, 217; Viña del Mar, Chile, Sept. 4, 1919, 1; Baños de Concones, via Roncaqua, Chile, Jan. 13, 1920, 292.

*Cestrum Schlechtendalii* Don. Tremembé, São Paulo, Brazil, May 30, 1922, 1913.

*Cestrum strigillatum* R. & P. Quito, Ecuador, Aug. 18, 1920, 911.

*Cestrum undulatum* R. & P. Choisica, Peru, July 22, 1920, 779.

*Cestrum* sp. Zapallar, Chile, Jan. 31, 1920, 302; Cochabamba, Bolivia, March 11, 1920, 395; Therezopolis, Rio de Janeiro, Brazil, Oct. 6, 1921, 1194; Paulista Park, São Paulo, Brazil, Apr. 15, 1922, 1733; La Falda, Argentina, Aug. 16, 1922, 2032.

Originally described from Juan Fernandez, Chile, this species has been previously reported in various sections of South America and is also common in Central America and the West Indies.

300. *UROMYCES MACULANS* (Pat.) Arth. Mycologia **10**: 124. 1918.

*Uromyces Cestri maculans* Pat. Bull. Soc. Myc. Fr. **28**: 140. 1912.

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*Cestrum calycinum* Willd. Sorata, Bolivia, Apr. 29, 1920, 584.

The specimen listed above bears aecia only and is assigned to *U. maculans* with considerable confidence. The species has not previously been reported for South America. It was originally described from Costa Rica and is also known in Guatemala and Salvador.

301. *Uromyces Salpichroae* Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis, rotundatis, 0.3–0.5 mm. diam., mox nudis, aurato-brunneis, pulverulentis, epidermide rupta cinctis; uredosporis ellipsoideis vel obovatis, 17–21 × 23–28  $\mu$ ; tunica hyalina vel pallide aurato-brunnea, 1–1.5  $\mu$  cr., crebre minuteque echinulata; poris obscuris, 2 vel 3, superaequalibus.

III. Teleutosoris uredosoris conformibus, compactis, pulvinatis, pallide castaneo-brunneis, ob germinationem cinerascens; teleutosporis obovatis, 13–19 × 25–38  $\mu$ , supra obtusis,

infra plerumque attenuatis; tunica hyalina vel parum cinnamomeo-brunnescenti, tenui,  $1\ \mu$  minusve, apice crassiore  $4\text{--}7.5\ \mu$ , levi; pedicello hyalino, sporam aequante vel brevior.

*Salpichroa diffusa* Miers. Cuenca, Ecuador, Sept. 10, 1920, 976.

*Salpichroa* sp. Sorata, Bolivia, May 1, 1920, 585 (type).

#### SPECIES ON SCROPHULARIACEAE

302. *CRONARTIUM COLEOSPORIOIDES* (Dietel & Holway) Arth. N. Am. Fl. 7: 123. 1907.

*Uredo coleosporioides* Dietel & Holway, Erythea 1: 247. 1893.

*Castilleja* sp. Quito, Ecuador, Aug. 21, 1920, 934.

The collection bears uredinia only and the urediniospores agree well with this species which seems not to have been previously reported from South America.

#### SPECIES ON BIGNONIACEAE

303. *Cerotelium Holwayi* Jackson, sp. nov.

II. Uredosoris hypophyllis, sparsis, numerosis, parvis,  $0.2\text{--}0.3$  mm. diam., cinnamomeo- vel castaneo-brunneis, pulverulentis, copiosis incurvatis paraphysibus circumdatis; paraphysibus numerosis, rectis vel saepius curvatis, apparenter compacta parte ad basim conjunctis,  $6\text{--}15 \times 35\text{--}60\ \mu$ ; tunica irregulariter, saepe magnopere, extus incrassata, hyalina usque castaneo-brunnescenti, apice acuta saepeque acuminata,  $2\text{--}4$  septata; uredosporis obovoideis,  $16\text{--}19 \times 21\text{--}28\ \mu$ ; tunica hyalina vel leniter tincta,  $1\ \mu$  cr., quandoque leniter incrassata usque  $2.5\ \mu$ , minutissime creberrimeque echinulata, poris obscuris praedita.

III. Teleutosoris hypophyllis, minutis, erumpentibus, columnaribus; teleutosporis catenulatis, recte transverseque adhaerentibus itaque columnas  $100\text{--}130 \times 100\text{--}165\ \mu$  altas efficientibus, breviter cylindraceis,  $12\text{--}15 \times 15\text{--}18\ \mu$ ; tunica hyalina vel leniter tincta, tenui  $1\ \mu$  minusve, levi.

*Bignoniaceae* (unidentified)

Jacarépaquá, Rio de Janeiro, Brazil, Nov. 16, 1921, 1315 (type); Mogy das Cruces, Brazil, July 4, 1922, 2001; San Francisco, Nictheroy, Rio de Janeiro, Brazil, Sept. 23, 1921, 1142; Pindamonhangaba, São Paulo, Brazil, May 4, 1922, 1812.

All the collections listed above are on different hosts. Only the first one, selected as the type, bears teliospores, the others bear uredinia only. There is some variation in the different collections and it is possible that more than one species is represented. We have not been able to determine whether any of the species of unconnected *Uredo* which have been described belong here. A specimen marked *Uredo luteola* Speg. on *Pyrostegia venusta* from Paraguay is similar in microscopic characters, but the gross appearance of the sori is quite different. We have been unable to locate a description of this species.

304. *PROSPODIUM AMPHILOPHII* (Dietel & Holway) Arth. Jour. Myc. 13: 31. 1907.

*Puccinia Amphilophii* Dietel & Holway, Bot. Gaz. 24: 30. 1897.

*Puccinia phlyctopus* Sydow, Monog. Ured. 1: 242. 1902.

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*Pithecoctenium* sp. Sylvestre, Rio de Janeiro, Brazil, Aug. 15, 1921, 1040; Nictheroy, Rio de Janeiro, Brazil, Aug. 18, 1921, 1049; Lapa, São Paulo, Brazil, June 4, 1922, 1938; Taipas, São Paulo, Brazil, June 10, 1922, 1947; Curityba, Paraná, Brazil, June 20, 1922, 1978.

I have assigned tentatively to this species a group of collections, bearing small urediniospores the outer wall of which does not swell in water, and in which the teliospores are noticeably constricted with little evidence of an outer wall. The pedicels are long and usually unadorned.

305. *Prosopodium anomalum* Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis, tarde nudis, obscure cinnamomeo-brunneis, pulverulentis, cuticula rupta conspicue cinctis; uredosporis parum irregulariter globoideis vel ellipsoideis, 20-25  $\mu$  diam. (tunica exteriori exclusa); tunica laminata, interiore cinnamomeo-brunnea, 2-3  $\mu$  cr., exteriori hyalina, usque 4  $\mu$  cr. inflata itaque annulum latum ramosum efformante, crebre minute verrucoso-echinulata; poris 2, aequatorialibus.

III. Teleutosoris uredosoris conformibus; teleutosporis late ellipsoideis, 27-30  $\times$  38-45  $\mu$ , utrinque rotundatis, non vel vix constrictis; tunica theobromina, 4-6  $\mu$  cr., poris lentissime incrassata, exteriori inconspicua, sparsius verrucosa, papillis



humilibus instructa; pedicello hyalino vel leniter tincta, inornato vel leniter disperseque appendiculato.

*Bignoniaceae* (unidentified) Mogy das Cruces, São Paulo, Brazil, July 4, 1922, 1997.

A species with rather large, dark teliospores and with sorus characters quite different from most species of *Prospodium*. The most characteristic difference, however, is in the urediniospores. In the latter, the outer wall seems to gelatinize in the form of a broad band. This band, which in most similar species is a single one running around the spore, in this species seems to fork on either side so that there are two broad bands at the apex of the spore. When seen in side view, the bands show as three points, two above and one at the base giving a triangular appearance to the spore outline. When seen in face view, there appears to be a complete, evenly thickened outer wall. The markings which appear to be confined to the bands, are close and of the verrucose type. No paraphyses were observed.

306. *PROSPODIUM APPENDICULATUM* (Wint.) Arth. Jour. Myc. 13: 31. 1907.

*Puccinia appendiculata* Wint. Flora 67: 262. 1884.

*Puccinia ornata* Hark. Proc. Calif., Acad. Sci., II, 2: 231. 1889.

*Puccinia medusaeoides* Arth. Bot. Gaz. 16: 226. 1891.

*Uredo cuticulosa* Ellis & Ev. Bull. Lab. Nat. Hist. Iowa. 4: 67. 1896.

*Puccinia cuticulosa* Arth. Mycologia 9: 83. 1917.

*Puccinia Tecomae* Sacc. & Sydow in Sacc. Syll. Fung. 14: 358. 1899.

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*Stenolobium Gaudichaudi* DC. Guayaquil, Ecuador, Aug. 1, 1920, 806.

*Stenolobium* sp. Hacienda del Urco, Urubamba Valley, Cuzco, Peru, July 4, 1920, 760; Huigra, Chimborazo, Ecuador, Aug. 5, 1920, 846.

Lagerheim collected this species in the same locality and on the same host as the collection first reported above. Otherwise the species has previously been reported from South America

only from Trinidad on *Stenolobium Stans*. The species is common in Central America and the West Indies on the last mentioned host and is known also from Mexico and Guatemala on *S. molle*.

**307. *Prospodium Arrabidaee* Jackson & Holway, sp. nov.**

O. Pycnidiis amphigenis caulicolisque, subcuticularibus, crebre in greges parvos aggregatis, punctiformibus, conspicuis, obscure brunneis, hemisphaericis, vel connoideis, 45–60  $\mu$  altis, 90–120  $\mu$  latis; interdum periphysisbus fasciculum 30  $\mu$  altum efformantibus.

III. Teleutosoris amphigenis vel caulicolis, subcuticularibus, obscure cinnamomeo-brunneis, soris foliiculis magnis confluentibus circa pycnidia circinantibus sed caulicolis elongatis areas obsoletas occupantibus praeditis, tardius nudis, pulverulentis, cuticula fissa plerumque cinctis; teleutosporis late ellipsoideis, magnitudine variabilibus, 18–27  $\times$  24–33  $\mu$ , utrinque rotundatis, leniter vel non constrictis; tunica obscure cinnamomeo-vel pallide castaneo-brunnea, 3–4  $\mu$  cr., exteriori hyalino, conspicua, moderate minuteque verrucosa; pedicello hyalino vel leniter tincta, brevi, deciduo.

*Arrabidaea* sp. (near *A. Blanchetii* DC.) Bello Horizonte, Minas Geraes, Brazil, Dec. 1, 1921, 1354.

It is with some hesitation that this microcyclic species and the one on *Cremastus* are described as distinct. It would appear, however, that there are a number of microcyclic species occurring on different host genera in the Bignoniaceae which may become systemic and cause witches brooms. These species are all much alike and possibly when better known should be assigned to one variable species. We hesitate, however, to assign them to *P. elegans* Schröt. though they appear to be similar.

**308. *Prospodium Cremastum* Jackson & Holway, sp. nov.**

O. Pycnidiis non visis.

III. Teleutosoris amphigenis caulicolisque, ubique in ramis junioribus deformatis dense dispositis, confluentibus, indefinitis, pulverulentis, obscure cinnamomeo-brunneis; cuticula rupta plerumque aegre visibili; teleutosporis ellipsoideis, 21–24  $\times$  27–30  $\mu$ , utrinque rotundatis, non vel leniter septo constrictis; pariete interiore pallide castaneo-brunneo, 1.5–2  $\mu$  cr., exteriori in aqua inflato, fere hyalino, 2–2.5  $\mu$  cr., minute crebreque verrucoso; papillis saepe coalescentibus; pedicello infra angustato, sporam aequante vel brevior.

*Cremastus sceptrum* Bur. & Schum. Bello Horizonte, Minas Geraes, Brazil, Nov. 24, 1921, 1331.

A microcyclic species which causes abundant distortion of the young shoots. Perhaps too close to *P. Arrabidaeae* and *P. elegans*. (See discussion under former species.)

**309. *Prospodium Holwayi* Jackson, sp. nov.**

II. Uredosoris hypophyllis, sparsis, rotundatis, parvis, 0.1–0.3 mm. diam., tardius nudis, pulverulentis, cinnamomeo-brunneis, cuticula rupta cinctis; uredosporis subgloboideis vel obovoideis,  $18\text{--}21 \times 22\text{--}26 \mu$ ; tunica pallide cinnamomeo-brunnea,  $1\text{--}1.5 \mu$ , moderate maximeque inconspicue verrucosa, poris 2 aequatorialibus praedita.

III. Teleutosoris uredosoris conformibus, castaneo-brunneis, pulverulentis; teleutosporis parum irregulariter ellipsoideis,  $22\text{--}25 \times 32\text{--}35 \mu$ , utrinque rotundatis, conspicue constrictis; tunica castaneo-brunnea, non laminata, tenui,  $1.5\text{--}2 \mu$ , supra poros non vel lentissime incrassata, apparenter tereti sed vere maxime inconspicue verrucosa; pedicello brevi, deciduo, in parte inserta lato, saepe lateraliter inserto, inornato.

*Pithecoctenium* ? sp. Taipas, São Paulo, Brazil, Feb. 7, 1922, 1541 (type); June 10, 1922, 1956.

This species is distinguished by the nearly smooth teliospores without evident outer layer and by the thin walled, unlaminated urediniospores.

**310. *Prospodium impolitum* Jackson & Holway, sp. nov.**

II. Uredosoris hypophyllis, sparsis vel gregariis, rotundatis, 0.2–0.4 mm. diam., obscure cinnamomeo-brunneis; cuticula rupta non visibili; paraphysibus copiosis, incurvatis,  $6\text{--}12 \times 45\text{--}90 \mu$ , apice acuminatis, sorum circumdantibus, basi apparenter conjunctis; tunica ex hyalina castaneo-brunnea, extus irregulariter incrassata, intus tenui; uredosporis lateraliter depressis, poris e facie visis, globosis,  $24\text{--}30 \mu$  diam., sed, e latere, ellipsoideis,  $19\text{--}24 \times 24\text{--}30 \mu$ ; pariete interiore pallide castaneo-brunneo,  $2\text{--}2.5 \mu$  cr., exteriore hyalino, aqua inflato, sparse echinulato; poris 2, aequatorialibus.

III. Teleutosoris uredosoris conformibus, obscure castaneo-brunneis, pulverulentis; paraphysibus uredosoris conformibus; teleutosporis late ellipsoideis,  $26\text{--}30 \times 36\text{--}42 \mu$ , utrinque rotundatis, septo non constrictis; tunica castaneo-brunnea,  $3\text{--}4 \mu$  cr., lamina exteriore non conspicua praedita, leniter tincta, apice

incrassata usque  $6\mu$ , valde sparseque verrucoso-echinulata, conspicue conice papillata; pedicello hyalino vel prope sporam leniter tincta, sporam aequante vel subdimidio longiore, inornato vel infra singulo orbi appendiculato.

*Haplolophium bracteatum* Cham. Campinas, São Paulo, Brazil, Apr. 3, 1922, 1691.

*Pyrostegia venusta* (Vell.) Presl. Juquery, São Paulo, Brazil, June 12, 1922, 1958 (type).

*Stizophyllus* sp. ? Anvim, São Paulo, Brazil, March 15, 1922, 1634.

*Tynnanthus* sp. Juquery, São Paulo, Brazil, Feb. 2, 1922, 1531.

*Bignoniaceae* unidentified. Juquery, São Paulo, Brazil, Feb. 2, 1922, 1530; São Roque, São Paulo, Brazil, March 21, 1922, 1665; Lapa, São Paulo, Brazil, March 24, 1922, 1674; June 3, 1922, 1936; São João, São Paulo, Brazil, July 2, 1922, 1996.

The description has been drawn largely from the second collection listed above, which has been selected as the type. Collections having the sori surrounded by conspicuous dark incurved paraphyses and with large urediniospores with conspicuous outer layer swelling in water, and with strongly marked teliospores, are included here. The outer wall of the urediniospore in this and other species having similar characteristics seems to be thickened in a broad band extending around the spore. It is visible as a colorless, thick halo when the spores lie in face view. When the spores lie on edge, that is, with pores in optical section, the band is conspicuous only at either end of the spore.

311. **Prospodium Lundiae** Jackson & Holway, sp. nov.

O. Pycnidiis amphigenis, subcuticularibus, paucis in omni grege collectis, maculis decoloratis insidentibus, punctiformibus, brunneolis, humiliter hemisphaericis,  $65-75 \times 135-160\mu$ ; periphysibus praesentibus, quandoque extrusis.

III. Teleutosoris amphigenis vel saepius hypophyllis, magnis, confluentibus, circa solum pycnidiorum circulum efformantibus, 1-2.5 mm. latis, tardius nudis, pallide castaneo-brunneis, pulverulentis, cuticula rupta conspicue cinctis; uredosporis in teleutosoris sitis globosis vel interdum ellipsoideis,  $24-32\mu$  diam.; pariete interiore castaneo-brunneo,  $2.5-3\mu$  cr., exteriore

hyalino, magnopere inflato, 3–4  $\mu$  cr., sparse echinulato; poris 2 aequatorialibus; paraphysibus paucis, per sorum dispersis, hyalinis, rectis, tunicis crassis instructis, 5–7  $\times$  45–60  $\mu$ , teleuto-sporis late ellipsoideis, 24–30  $\times$  36–42  $\mu$ , utrinque rotundatis, non constrictis; tunica castaneo-brunnea, 2.5–3  $\mu$  cr., apice plerumque subcrassiuscula usque 6  $\mu$ , exteriore inconspicua, hyalina vel tincta, sparse minuteque verrucosa, humiliter papillata sed apparenter fere levi; pedicello hyalino, sporam aequante vel brevior, inornata.

*Lundia nitidula* DC. Santo Amaro, São Paulo, Brazil, Feb. 16, 1922, 1563 (type).

*Lundia* sp. Tremembé, São Paulo, Brazil, May 30, 1922, 1908.

This distinct species has the aspect of a microcyclic form but urediniospores and teliospores occur apparently equally abundantly in the primary sori. No other sori were observed. The teliospores appear nearly smooth.

312. *Prospodium palmatum* Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, subcuticularibus, sparsis vel gregariis, parvis, rotundatis, 0.1–0.3 mm. diam., mox nudis, cinnamomeo-brunneis, pulverulentis, cuticula rupta inconspicuis; paraphysibus paucis, inconspicuis, incoloribus, cylindraceis, 5–7  $\times$  30–45  $\mu$ ; uredosporis globosis, cum pariete exteriore inflato 22–27  $\mu$  diam.; tunica laminata, intus cinnamomeo-brunnea, 1–1.5  $\mu$  cr., extus hyalina, magnopere tumescente ad 3–5  $\mu$ , moderate valdeque echinulata; poris 2, aequatorialibus.

III. Teleutosoris uredosoris conformibus, castaneo-brunneis; teleutosporis late ellipsoideis, 22–25  $\times$  30–36  $\mu$ , utrinque rotundatis, septo vix vel non constrictis; tunica castaneo-brunnea, 3–4  $\mu$  cr., non vel lentissime supra poros incrassata; lamina exteriore gelatinosa, inconspicua, moderate verrucosa; papillis conicis inter se 2–3  $\mu$  distantibus; pedicello hyalino, sporam aequante vel leniter superante, plerumque lateraliter inserto, basi irregulariter palmato-ramificato.

*Tecoma alba* Cham. Poços de Caldas, São Paulo, Brazil, Apr. 10, 1922, 1722.

It is possible that *Uredo longiaculeata* P. Henn. may prove to belong here. The species is distinguished by the small urediniospores which have a diameter of 16–19  $\mu$  excluding the outer wall, and by the peculiar palmately branched base of the teliospore pedicel.

**313. *Prospodium reticulatum* Jackson & Holway, sp. nov.**

II. Uredosoris hypophyllis, subcuticularibus, sparsis, rotundatis, parvis, 0.2–0.3 mm. diam., tardius nudis, cinnamomeo-brunneis, pulverulentis; cuticula rupta conspicua; uredosporis obovatis, uno latere irregularibus,  $22\text{--}25 \times 28\text{--}30 \mu$ ; tunica tenui, non laminata,  $1\text{--}1.5 \mu$ , pallide cinnamomeo-brunnea, valde sparseque echinulata; poris parum obscuris, 2, subaequatorialibus.

III. Teleutosporis uredosoris immixtis, late ellipsoideis,  $23\text{--}27 \times 36\text{--}42 \mu$ , utrinque rotundatis, plerumque septo conspicue constrictis, tunica  $3\text{--}3.5 \mu$  cr., castaneo-brunnea, exteriore inconspicua, minute aequaliter reticulata; pedicello prope septum saepe inserto, hyalino, brevi.

*Bignoniaceae* (unidentified) Lapa, São Paulo, Brazil, June 4, 1922, 1942.

Only a few teliospores of this apparently distinct species were seen. The wall is beautifully and uniformly reticulated with fine, even meshes. The pedicel is short and, so far as could be determined, unadorned.

**314. *Prospodium Stizophyllii* Jackson & Holway, sp. nov.**

O. Pycnidiis non visis, probaliter carentibus.

III. Teleutosoris hypophyllis, in maculis flavescentibus aggregatis, plerumque nerviculis et costis suffultis, elongatis 0.5–1.5 mm. longis, tardius nudis, pulverulentis, cuticula rupta cinctis; teleutosporis difformibus, aliis bicellularibus ellipsoideis,  $23\text{--}26 \times 34\text{--}39 \mu$ , utrinque rotundatis, plerumque septo visibiliter constrictis; aliis unicellularibus (mesosporis) parum irregulariter globosis,  $24\text{--}33 \mu$  diam., poro uno laterali instructis; tunica castaneo-brunnea,  $2.5\text{--}3.5 \mu$  cr., supra poros leniter incrassata, exteriore inconspicua, leniter tinctorum, minute rugoso-reticulata; pedicello hyalino vel leniter tinctorum, brevi, deciduo.

*Stizophyllum perforatum* Mier. Ave. Paulista Park. São Paulo, Brazil, March 5, 1922, 1613.

This is a very interesting species. The sori occur in groups on yellowish spots and extend along the veins or the midrib when the spot is in the centre of the leaf. The aspect is that of a microform. No pycnia were observed. The mesospores are as abundant as the two-celled spores and occur intermixed. At first glance one would be likely to interpret them as uredinio-spores but there is only one pore, always lateral, and the surface sculpturing is like that of the two-celled spores. The mesospores

appear to be flattened laterally so that, when the pore is in face view, the spore appears to be globoid, when the pore is in optical section, the spore appears flattened on the side where the pore is located. Paraphyses were not observed.

315. **Prospodium tecomicola** (Speg.) Jackson & Holway, comb. nov.

*Puccinia tecomicola* Speg. Anal. Mus. Nac. Hist. Nat. Buenos Aires 31: 35. 1922.

*Tecoma* sp. Mogy das Cruces, São Paulo, Brazil, July 4, 1922, 2004.

This collection has been compared with the type of *P. tecomicola* Speg. and we can detect no essential difference.

316. **Uredo cerotelioides** Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis, rotundatis, parvis, 0.2-0.3 mm. diam., tarde nudis, diu epidermide tectis, pulveraceis, pallide cinnamomeo-brunneis; paraphysibus copiosis sed inconspicuis, sorum circumdantibus, plerumque incurvatis, brevibus, 6-9 × 24-36  $\mu$ , apice obtusis, plerumque 1-septatis; tunica hyalina vel obscure cinnamomeo-brunnea, extus apiceque irregulariter incrassata; uredosporis obovatis, 15-18 × 24-28  $\mu$ ; tunica hyalina vel pallide cinnamomeo-brunnea, tenui 1  $\mu$  minusve, minute crebreque verrucosa.

*Bignoniaceae* (unidentified) Garulhos, São Paulo, Brazil, June 1, 1922, 1927 (type); Juquery, São Paulo, Brazil, June 12, 1922, 1960.

This species is probably the uredinial stage of a *Cerotelium*. It differs markedly from *C. Holwayi*, primarily in the character of the sorus and in the paraphyses. In this species the paraphyses are short, much less conspicuous and obtuse at the apex.

317. **Uredo Delostomae** Jackson & Holway, sp. nov.

II. Uredosoris subcuticularibus, hypophyllis, sparsis, rotundatis, 0.3-0.5 mm. diam., mox nudis, pulverulentis, obscure cinnamomeo-brunneis, dein albidis, cuticula rupta inconspicua cinctis; uredosporis globosis, 24-27  $\mu$  diam.; pariete pallide castaneo-brunneo, tenui, 1.5-2  $\mu$ , moderate prominenter echinulato, poris obscuris praedito.

*Delostoma Morleyanum* Rose, Huigra, Chimborazo, Ecuador, Aug. 4, 1920, 840.

## SPECIES ON ACANTHIACEAE

318. PUCCINIA BLECHI Lagerh. Bull. Soc. Myc. Fr. 11: 214. 1895.

*Blechnum Brownei* Juss. Guayaquil, Ecuador, July 30, 1920, 796.

The collection listed above is from the type locality for Lagerheim's species. Arthur (N. Am. Fl. 7: 415. 1921) lists the above name as a synonym of *P. Ruelliae* (B. & Br.) Lagerh. We prefer, for the present, however, to list the species separately.

319. PUCCINIA PARANAHYBAE P. Henn. Hedwigia 34: 320. 1895.

*Ruellia longifolia* (Pohl.) Griseb. Prata, São Paulo, Brazil, Apr. 7, 1922, 1707.

A microcyclic form which answers Henning's description well. The type has not been available. It was collected at Gogaz, Brazil, by Ule (No. 2004). An earlier collection recorded later (Hedwigia 35: 235. 1896) made at St. Catharina, Brazil (Ule, 908), is on the same host as the above. The species is also reported from Argentina.

320. *Puccinia praevara* Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, quandoque epiphyllis, sparsis vel gregariis, in maculis decoloratis constipatis, parvis, rotundatis, 0.3–0.4 mm. diam., tarde nudis, pulverulentis, castaneo-brunneis, epidermide cinerea diu tectis; uredosporis globosis vel ellipsoideis, lateraliter parum depressis,  $21\text{--}27 \times 27\text{--}32 \mu$ ; pariete obscure castaneo-brunneo,  $2.5\text{--}3 \mu$  cr., minutissime moderateque echinulato, area levi circum poros 2 aequatoriales praedito.

III. Teleutosoris uredosoris conformibus; teleutosporis irregulariter ellipsoideis,  $24\text{--}28 \times 30\text{--}42 \mu$ , utrinque rotundatis, non vel lentissime septo constrictis; tunica castaneo-brunnea,  $2.5\text{--}4 \mu$  cr., supra poros leniter vel non incrassata, obscure verrucoso-rugosa; pedicello brevi, hyalino, deciduo, saepe lateraliter inserto.

*Ruellia viscidus* Nees. Guayaquil, Ecuador, July 31, 1920, 800.

321. PUCCINIA STENANDRI Dietel & Neger, in Engl. Bot. Jahrb. 22: 352. 1896.

*Stenandrium dulce* Nees. Panimavida, Chile, Dec. 17, 1919, 241.



This species appears to be distinct and was originally collected near Concepcion, Chile, on the same host. It does not appear to have been reported elsewhere.

322. **Uredo Aphelandrae** Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis vel interdum in maculis decoloratis subhypertrophicis aggregatis, obscure cinnamomeo-brunneis, magnis, rotundatis, 0.5–1.0 mm. diam., tarde nudis, pulverulentis, epidermide rupta cinctis; uredosporis obovatis,  $21\text{--}27 \times 27\text{--}34 \mu$ ; tunica cinnamomeo-brunnea,  $1.5\text{--}2 \mu$  cr., sparse valdeque echinulata; poris prominentibus, 2, aequatorialibus.

*Aphelandra prismatica* Hiern. Alto da Serra, São Paulo, Brazil, June 14, 1922, 1970.

This species seems to differ from the following; though the spores are about the same size and have similar wall markings, the gross aspect of the two species is quite different.

323. **Uredo Cyrtantherae** Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, in maculis decoloratis aggregatis, parvis, irregularibus, saepe confluentibus, 0.3–0.4 mm. diam., tardius nudis, pallide cinnamomeo-brunneis, pulverulentis, epidermide rupta cinctis; uredosporis late ellipsoideis vel obovoideis,  $21\text{--}24 \times 27\text{--}34 \mu$ ; tunica pallide aurato-brunnea,  $1.5\text{--}2.5 \mu$  cr., sparse valdeque echinulata, poris obscuris praedita.

*Cyrtanthera Sellowiana* Nees. Cantareira, São Paulo, Brazil, May 30, 1922, 1917.

SPECIES ON RUBIACEAE

324. **Aecidium borrieriicola** Jackson & Holway, sp. nov.

O. Pycnidiis amphigenis, plerumque epiphyllis, in maculis decoloratis aggregatis, profunde insidentibus, irregulariter ellipsoideis,  $90\text{--}120 \mu$  latis,  $90\text{--}135 \mu$  altis, prominenter periphysatis.

I. Aecidiis hypophyllis, per aream magnam 0.5–1.5 cm. diam., laxe sparsis, maculis decoloratis insidentibus, parvis, rotundatis,  $165\text{--}200 \mu$  diam., cupulatis vel breviter columnaribus, albidis; peridio albido, firmo, margine erecto parumque revoluta, eroso; cellulis peridialibus rhomboideis,  $18\text{--}20 \times 28\text{--}32 \mu$ , subforte imbricatis; pariete exteriori  $4\text{--}6 \mu$  cr., levi, interiore  $3\text{--}4 \mu$ , crasse verrucoso-rugoso; aecidiosporis ellipsoideis vel oblongis,  $12.5\text{--}15 \times 17\text{--}22 \mu$ ; tunica hyalina, tenui,  $1 \mu$  minusve, apice incrassata usque  $6 \mu$ , subtiliter crebreque verrucosa.

*Borreria angustifolia* C. & S. Campos do Jordão, São Paulo, Brazil, Apr. 30, 1922, 1794.

This species, while having somewhat the same general appearance, is quite different from *A. Holwayi* in aeciospore characters. The aecia are larger and the general appearance is somewhat coarser.

**325. *Aecidium Fuchsiae* Jackson & Holway, sp. nov.**

O. Pycnidiis paucis, inconspicuis, epiphyllis, subepidermicis, humilibus, parum triangularibus, non profunde insidentibus, 55–60  $\mu$  altis, 125–135  $\mu$  latis; inconspicue periphysatis.

I. Aecidiis hypophyllis, crebre in maculis leniter hypertrophicis rubidisque aggregatis, parvis, cupulatis; peridio flavescenti, margine eroso instructo; cellulis peridialibus contiguis vel leniter imbricatis, 15–18  $\times$  28–32  $\mu$ ; pariete exteriore crasso, 5–6  $\mu$ , levi, interiore 1.5–2  $\mu$ , crasse verrucoso-rugoso; aecidiosporis angulato-globosis, 18–24  $\mu$  diam. vel oblongis, 16–18  $\times$  21–24  $\mu$ ; tunica hyalina, tenui, 1–1.5  $\mu$ , minute sed visibiliter verrucosa.

*Fuchsia dependens* Hook. El Chaco, Prov. Sur Yungas, Bolivia, May 24, 1920, 643 (type).

*Fuchsia serratifolia* R. & P. San Felipe, Prov. Sur Yungas, Bolivia, May 21, 1920, 632.

**326. *Aecidium Holwayi* Jackson, sp. nov.**

O. Pycnidiis amphigenis, numerosis, in centro macularum decoloratarum aggregatis vel inter aecidia sparsis, profunde insidentibus, subepidermicis, globosis vel depresso globosis, 90–105  $\mu$  altis, 100–135  $\mu$  latis; periphysibus non extrusis.

I. Aecidiis hypophyllis, per areas magnas decoloratas 1–1.5 cm. diam. laxe sparsis, parvis, 125–135  $\mu$  diam., albidis, breviter cylindraceis, peridio erecto, firmo, margine eroso, albo; cellulis peridialibus regulariter rhomboideis, subforte imbricatis, 18–21  $\times$  28–32  $\mu$ ; pariete exteriore crasso, 5–7  $\mu$ , levi, interiore 2–3  $\mu$  cr., minute crebreque verrucoso-rugoso; aecidiosporis globosis vel late ellipsoideis, parvis, 11–13  $\times$  15–18  $\mu$ ; tunica hyalina, tenui, 1  $\mu$  minusve, inconspicue et subtilissime verrucosa sed apparenter levi.

*Borreria latifolia* (Aubl.) Schum. Mandaque, São Paulo, Brazil, March 23, 1922, 1670, May 25, 1922, 1893 (type).

A very different species from *Aecidium borreriicola*, characterized by the small aecia occurring loosely scattered over considerable areas, but apparently not systemic. The aeciospores are small and not thickened at the apex.

327. *PUCCINIA AMBIGUA* (Alb. & Schw.) Lagerh. Bubak, Sitz.-ber. Böhm. Ges. Wiss. 1898: 14. 1898.

*Aecidium Galii ambiguum* Alb. & Schw. Consp. Fung. 116. 1805.

*Galium aparine* L. Viña del Mar, Chile, Sept. 10, 1919, 16; Concepcion, Chile, Oct. 29, 1919, 148.

A common -opsis form in North America and Europe, which does not seem to have been previously reported from South America.

328. *Puccinia Coccocypseli* Jackson & Holway, sp. nov.

O. Pycnidiis non visis, probaliter carentibus.

III. Teleutosoris hypophyllis, maculis flavescentibus insidentibus, in greges 3–8 mm. diam. dense confertis, saepe concentricae dispositis, cinnamomeo- vel pallide castaneo-brunneis, parvis, rotundatis vel parum irregularibus, 0.2–0.4 mm. diam., plerumque distinctis, mox nudis, pulvinatis, epidermide rupta plerumque inconspicuis; teleutosporis ellipsoideis vel oblongo-fusoideis, 10–13 × 24–34  $\mu$ , supra rotundatis vel saepius obtusis, infra rotundatis vel quandoque ad pedicellum attenuatis, septo leniter vel non constrictis; tunica hyalina, vel pallide aurato-brunnea, 1–1.5  $\mu$ , supra leniter vel non incrassata usque 3  $\mu$ , levi; pedicello hyalino, fragili, sporam aequante vel saepius brevior.

*Coccocypselum Condalia* Pers. Campos do Jordão, São Paulo, Brazil, Apr. 27, 1922, 1777.

A micro-form with characters sufficiently distinct to justify separation.

329. *Puccinia concumulata* Jackson & Holway, sp. nov.

O. Pycnidiis amphigenis caulicolisque, paucis, crebre gregariis, conspicuis, profunde insidentibus, magnis, subglobosis, 100–135  $\mu$  altis, 135–150  $\mu$  latis, periphysibus aegre conspicuis praeditis.

I. Aecidiis hypophyllis caulicolisque, paucis, maculis subhypertrophicis insidentibus, majusculis, cupulatis vel breviter cylindraceis; peridio flavescenti, erecto, firmo, margine eroso; cellulis peridialibus inter se firme conjunctis, parum imbricatis, 18–22 × 28–34  $\mu$ ; pariete exteriori 3–5  $\mu$ , levi, interiori 1.5–2  $\mu$ , minute crebreque verrucoso; aecidiosporis angulato-globosis, 19–24  $\mu$ ; tunica hyalina, tenui, 1  $\mu$  minusve, minutissime verrucosa.

II. Uredosoris caulicolis, elongatis, castaneo-brunneis, tardius

nudis, pulverulentis, epidermide rupta cinctis; uredosporis late ellipsoideis,  $21-27 \times 30-38 \mu$ ; tunica castaneo-brunnea,  $2.5-3 \mu$  cr., minute sparseque echinulata; poris prominentibus, 4, aequatorialibus.

III. Teleutosoris cauliculis, elongatis, saepe confluentibus complures mm. caulem sequentibus, theobrominis, mox nudis, pulvinatis, epidermide rupta plerumque cinctis; teleutosporis variabilibus, oblongis, clavatis vel cylindraceis,  $15-22 \times 45-100 \mu$ , supra rotundatis vel saepius obtusis, infra plerumque attenuatis, septo leniter vel non constrictis; tunica tenui,  $1-1.5 \mu$ , ex aurato-castaneo-brunnea, apice incrassata ad  $6-10 \mu$ , levi; pedicello hyalino, sporam aequante vel duplo superante.

*Galium* sp. La Falda, Argentina, Aug. 14, 1922, 2023.

A very distinct and beautiful species easily separated from others on *Galium* by the urediniospore and teliospore characters. It is possible that *Aecidium Arechavaletae* Speg. may prove to be synonymous. No specimens have been available.

330. PUCCINIA LATERITIA Berk. & Curt. Jour. Acad. Sci. Phila. II, 2: 281. 1853.

*Puccinia spermacoces* Berk. & Curt. Grevillea 3: 53. 1894.

*Puccinia Houstoniae* Sydow, Hedwigia, Beibl. 40: 126. 1901.

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*Diodia Radula* C. & S. Lapa, São Paulo, Brazil, March 24, 1922, 1673; Santa Anna, São Paulo, Brazil, May 25, 1922, 1878.

*Diodia rigida* (H.B.K.) C. & S. Sabara, Minas Geraes, Brazil, Dec. 2, 1921, 1360; Campinas, São Paulo, Brazil, Apr. 2, 1922, 1689.

*Spermacoce tenuior* L. Hacienda Anacuri, Nor Yungas, Bolivia, June 5, 1920, 724; Rio de Janeiro, Brazil, Aug. 27, 1921, 1076; Gavea, Rio de Janeiro, Brazil, Sept. 8, 1921, 1099; Prata, São Paulo, Brazil, Apr. 7, 1922, 1706; Guarujá, São Paulo, Brazil, July 12, 1922, 2006.

331. PUCCINIA PUNCTATA Link, Ges. Nat. Freunde Berlin Mag. 7: 30. 1815.

*Puccinia Galii* Schw. Schr. Nat. Ges. Leipzig 1: 73. 1822.

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*Galium cochabambense* Rusby, Cochabamba, Bolivia, March 10, 1920, 390.

332. *UREDOR BORRERIAE* (P. Henn.) Kern & Whetzel, *Mycologia* **18**: 42. 1926.

*Uromyces Borreriae* P. Henn. *Hedwigia* **35**: 227. 1896.

*Borreria verticillata* (L.) Mey. Rio de Janeiro, Brazil, Aug. 10, 1921, 1011.

333. *UREDOR PSYCHOTRIICOLA* P. Henn. *Hedwigia* **34**: 321. 1895.

*Palicourea crocea* R. & S. Portovelo, Prov. del Oro, Ecuador, Sept. 23, 1920, 1001.

*Psychotria* sp. Petropolis, Rio de Janeiro, Brazil, Oct. 22, 1921, 1242; Cantareira, São Paulo, Brazil, May 30, 1922, 1918.

334. *UROMYCES EMMEORRHIZAE* Sydow, *Ann. Myc.* **28**: 38. 1930.

*Emmeorrhiza umbellata* (Spreng.) Schum. Hacienda La Florida, Sur Yungas, Bolivia, May 28, 1920, 672; Therezopolis, Rio de Janeiro, Brazil, Oct. 6, 1921, 1196.

This species was recognized as an undescribed species by Prof. Holway, who sent it to me in 1920, marked *Uromyces Emmeorrhizae* n. sp. It has, however, been recently described on the same host from Venezuela by Sydow. The collection from Bolivia shows old aecia, too imperfect for description, but their presence serves to indicate that the species is a long cycled form.

#### SPECIES ON VALERIANACEAE .

335. *Puccinia vinulla* Jackson & Holway, sp. nov.

II. *Uredosoris amphigenis*, sparsis vel in maculis decoloratis aggregatis, circa sorum medianum saepe concentricis dispositis, rotundatis, 0.2–1.0 mm. diam., pallide aurato-brunneis, tarde nudis, pulverulentis, epidermide rupta cinctis, apophysatis; uredosporis ellipsoideis vel obovatis, 18–21 × 22–30  $\mu$ ; tunica hyalina vel pallide flavo-brunnescenti, 1.5–2.5  $\mu$  cr., moderate parumque prominenter echinulata, poris obscuris praedita.

III. *Teleutosoris*, paucis, uredosoris conformibus, compactis; teleutosporis ellipsoideis vel late clavatis, 18–22 × 33–45  $\mu$ , supra rotundatis, infra rotundatis vel attenuatis, septo leniter constrictis; tunica hyalina vel pallidissime flavescenti, 1–1.5  $\mu$  cr., angulis apiceque leniter incrassata ad 2–3.5  $\mu$ , levi; pedicello hyalino, sporam aequante vel brevior.

*Valeriana scandens* Loebl. Campos do Jordão, São Paulo, Brazil, Apr. 21, 1922, 1746.

Distinguished by the nearly colorless smooth walled teliospores.

336. *Uredo quitensis* Jackson & Holway, sp. nov.

II. *Uredosoris hypophyllis*, sparsis, rotundatis vel quandoque elongatis, 0.4–1.0 mm. diam., pallide aurato-brunneis, tarde nudis, pulverulentis, epidermide inflata diu tectis, aparaphysatis; uredosporis ellipsoideis vel obovatis,  $21\text{--}24 \times 30\text{--}36 \mu$ ; tunica hyalina vel pallide flavescenti,  $1\text{--}1.5 \mu$  cr., moderate tenuiter echinulata, poris obscuris praedita.

*Valeriana microphylla* H.B.K. Quito, Ecuador, Aug. 23, 1920, 943.

This *Uredo* resembles somewhat the uredinial stage of the preceding species; the spores, however, are larger, the markings less prominent and somewhat more closely spaced. It doubtless belongs to a related species of *Puccinia*.

SPECIES ON CUCURBITACEAE

337. *Uromyces Anguriae* Jackson & Holway, sp. nov.

II. *Uredosoris hypophyllis*, sparsis vel gregariis, obscure cinnamomeo-brunneis, suborbicularibus, 0.2–1.0 mm. diam., tarde nudis, pulverulentis, epidermide rupta cinctis; uredosporis ellipsoideis vel obovatis,  $18\text{--}21 \times 24\text{--}28 \mu$ ; tunica cinnamomeo-brunnea,  $1.5\text{--}2 \mu$ , minutissime sparsiusque echinulata; poris 2, subaequatorialibus.

III. *Teleutosoris hypophyllis*, sparsis vel gregariis, atro-brunneis, suborbicularibus, 0.2–0.5 mm. diam., tarde nudis, compactis, saepe epidermide cinerea diu tectis; teleutosporis subglobois vel late ellipsoideis,  $24\text{--}27 \times 30\text{--}38 \mu$ , infra rotundatis sed supra obtusis vel acutis; tunica castaneo-brunnea,  $2.5\text{--}4 \mu$ , apice umbone pallidiore supra porum incrassata ad  $6\text{--}12 \mu$ , minutissime obscurissime verrucoso-rugosa, apparenter levi, pedicello hyalino brevi deciduo praedita.

*Anguria Warmingiana* Cogn. Paineiras, Rio de Janeiro, Brazil, Aug. 17, 1921, 1045; Petropolis, Rio de Janeiro, Brazil, Dec. 29, 1921, 1432 (type).

Old aecia, too imperfect for proper description, are present in the first collection, indicating that the species is a eu-form. These are accompanied by prominent pycnia. The aecia appear

to be without evident peridium, deep seated, forming cavities in the somewhat hypertrophied tissues. The aeciospores are ellipsoid, 18–22 by 24–28  $\mu$ , with colorless walls, 1–1.5  $\mu$  thick, rather coarsely and prominently verrucose.

338. *UROMYCES NOVISSIMUS* Speg. Anal. Soc. Ci. Argent. 10: 134. 1880.

*Uredo novissimus* Speg. Anal. Mus. Nac. Buenos Aires 6: 235. 1899.

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*Cayaponia tayuya* Mart. Gavea, Rio de Janeiro, Brazil, Sept. 8, 1921, 1095.

*Cayaponia* sp. Sylvestre, Rio de Janeiro, Brazil, Sept. 16, 1921, 1115.

339. *Uromyces ratus* Jackson & Holway, sp. nov.

O. Pycnidiis amphigenis, paucis, punctiformibus, subepidermicis, obscure brunneis, profunde insidentibus, ellipsoideis, 90–105  $\mu$  latis, 105–120  $\mu$  altis; periphysibus non extrusis.

II. Uredosoris primariis amphigenis, gregariis, pycnidia circumdantibus, uredosoris secundariis sparsis vel gregariis, parvis, rotundatis, 0.3–0.8 mm. diam., mox nudis, obscure cinnamomeo-brunneis, pulverulentis, epidermide fissa cinctis; uredosporis ellipsoideis vel obovoideis, saepe triangularibus, 22–27  $\times$  27–32  $\mu$ ; tunica cinnamomeo-brunnea, tenui, 1–1.5  $\mu$ , parum prominenter sparseque echinulata; poris 2, aequatorialibus vel parum subaequatorialibus.

III. Teleutosoris hypophyllis, mox nudis, castaneo-brunneis, compactis, dein pulvinatis, tandem germinando cinerascens; epidermide rupta inconspicua; teleutosporis subglobosis vel ellipsoideis, 24–27  $\times$  27–38  $\mu$ , infra rotundatis sed supra obtusis; tunica 1.5–2  $\mu$  cr., pallide castaneo-brunnea, apice lamella pallidiore tunicae exterioris incrassata, levi; pedicello hyalino, sporam duplo aequante vel brevior.

*Cayaponia ternata* Cogn. Petropolis, Rio de Janeiro, Brazil, Oct. 27, 1921, 1251.

This species differs from *U. novissimus* Speg. in the larger urediniospores somewhat more prominently echinulate. In the latter species the urediniospores are 20–28  $\mu$  long with decidedly subequatorial pores. The teliospores are much the same in the two species, perhaps slightly smaller in *U. novissimus*, which also has slightly thicker walls, concolorous at apex.

The size of both spores in *U. ratus* is smaller than in *U. Cayaponiae* P. Henn.

## SPECIES ON CARDUACEAE

## (Tribe Vernonieae)

340. COLEOSPORIUM ELEPHANTOPODIS (Schw.) Thüm. Myc. Univ. 953. 1878.

*Uredo Elephantopodis* Schw. Schr. Nat. Ges. Leipzig 1: 70. 1822.

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*Elephantopus mollis* H.B.K. Hacienda La Florida, Sur Yungas, Bolivia, May 26, 1920, 655; Paissaguera, Near Santos, São Paulo, Brazil, Feb. 9, 1922, 1548.

*Elephantopus* sp. Jardim Botânico, Rio de Janeiro, Brazil, Aug. 11, 1921, 1016; Guarujá, Santos, São Paulo, Brazil, July 13, 1922, 2012.

*Orthopappus angustifolius* (Sw.) Gleason, Piassaguera, Near Santos, São Paulo, Brazil, Feb. 9, 1922, 1546; Cantareira, São Paulo, Brazil, Feb. 18, 1922, 1570.

341. PUCCINIA PIPTOCARPHAE P. Henn. Hedwigia 35: 240. 1896.

*Piptocarpha cinerea* (Sch. Bip.) Baker, Therezopolis, Rio de Janeiro, Brazil, Oct. 9, 1921, 1201.

*Piptocarpha oblonga* (Gardn.) Baker, Bosque da Saude, São Paulo, Brazil, Jan. 31, 1922, 1522.

*Piptocarpha oblonga ovatifolia* Baker, Bosque da Saude, São Paulo, Brazil, Jan. 31, 1922, 1519, May 27, 1922, 1897.

*Piptocarpha* sp. Barbacena, Minas Geraes, Brazil, Dec. 13, 1921, 1394; Villa Prudente, São Paulo, Brazil, June 9, 1922, 1945; Guarujá, Santos, São Paulo, Brazil, July 12, 1922, 2009.

All the collections showing absence of paraphyses and with teliospores about 45–60  $\mu$  long are included here. There seems to be considerable variation in both teliospores and urediniospores. It is possible that there are more species in this group than have been recognized.

342. *Puccinia seorsa* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, paucis in greges confertos dispositis, maculis magnis decoloratis insidentibus, punctiformibus, globosis,



magnis, profunde insitis, 210–270  $\mu$  diam., periphysibus non extrusis.

I. Aecidiis hypophyllis, paucis, pycnidiis contrappositis, peridio firmo flavescenti cylindraceo praeditis; cellulis peridialibus oblongis, 15–18  $\times$  45–60  $\mu$ , leniter imbricatis, tunica exteriori 2–3  $\mu$  cr., levi, interiore 2–3  $\mu$  cr., crebre prominenter verrucosa; aecidiosporis globosis vel late ellipsoideis, 24–30  $\times$  28–36  $\mu$ , tunica hyalina vel pallide aurato-brunnea, 2–2.5  $\mu$  cr., prominenter minuteque verrucosa.

II. Uredosoris hypophyllis, sparsis vel gregariis, parvis, rotundatis, 0.2–0.4 mm. diam., castaneo-brunneis, mox nudis, pulverulentis; epidermide rupta non visibili; paraphysibus copiosis, sorum circumdantibus, curvatis, longitudine 50–160  $\mu$  et latitudine 12–18  $\mu$ ; variabilibus; tunica uniformiter tenui 1  $\mu$  minusve vel saepius convexo latere ad 3  $\mu$  irregulariter incrassata; uredosporis globosis vel late ellipsoideis 26–30  $\times$  28–32  $\mu$ ; tunica castaneo-brunnea, 2–3  $\mu$  cr., moderate prominenterque echinulata, poris 4 sparsis praedita.

III. Teleutosoris hypophyllis, sparsis, pulvinatis, castaneo-brunneis, ob germinationem cinerascens; paraphysibus uredosoris conformibus; teleutosporis cylindraceis vel oblongis, longitudine variabilibus, 16–26  $\times$  50–120  $\mu$ , supra obtusis, infra ad pedicellum contractis, cellula superiore fusiformi praeditis, septo leniter constrictis; tunica pallide castaneo-brunnea, tenui, 1  $\mu$ , angulis cellulae inferioris leniter sed uno latere pori germinativi apice usque 3  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel brevior.

*Piptocarpha axillaris* (Less.) Baker, Taipas, São Paulo, Brazil, Feb. 6, 1922, 1540 (type); Mandaque, São Paulo, Brazil, May 25, 1922, 1893-1/2.

*Piptocarpha* sp. Petropolis, Rio de Janeiro, Brazil, Oct. 18, 1921, 1227; São Paulo, Brazil, Jan. 23, 1922, 1494; Bosque da Saude, São Paulo, Brazil, Jan. 29, 1922, 1508; Reserva Florestal, Itatiaia, Rio de Janeiro, Brazil, May 6, 1922, 1805.

This long cycled species is distinguished by the presence of abundant paraphyses with the diploid sori and by the teliospore characters. The teliospores are quite variable in length in different collections. They all have the pore of the apical cell slightly at one side and the thickening is greater on one side.

**343. *Puccinia valentula* Jackson & Holway, sp. nov.**

II. Uredosoris hypophyllis, sparsis, rotundatis, parvis, 0.2–0.4 mm. diam., mox nudis, obscure cinnamomeo-brunneis, pulverulentis; epidermide fissa visibili; paraphysisibus soro circumdantibus, copiosis, cylindraceis vel leniter incurvatis,  $12\text{--}22 \times 90\text{--}160\ \mu$ , tunica uniformiter tenui,  $1\ \mu$  minusve, apice quandoque, ad  $3\ \mu$  incrassata, aurato-brunnea; uredosporis globoideis,  $24\text{--}27\ \mu$ ; pariete pallide cinnamomeo-brunneo,  $2\text{--}2.5\ \mu$  cr., minutissime moderatissimeque echinulato, poris obscuris (3 pluribusve) praedito.

III. Teleutosoris uredosoris conformibus, castaneo-brunneis, pulverulentis; paraphysisibus uredosoris conformibus; teleutosporis late ellipsoideis vel subglobosis,  $26\text{--}30 \times 32\text{--}36\ \mu$ , utrinque rotundatis, non constrictis; tunica castaneo-brunnea,  $2.5\text{--}3\ \mu$  cr., supra poros vix sed magnopere angulis incrassata, minute inconspicue verrucosa sed apparenter levi; poro cellulae inferioris basali; pedicello hyalino, brevi, deciduo.

*Piptocarpha axillaris* (Less.) Baker, São Paulo, Brazil, Feb. 6, 1922, 1539 (type).

*Piptocarpha* sp. São Paulo, Brazil, Feb. 15, 1922, 1562.

A species with very different characters from any previously described on *Piptocarpha*. It is possible that in collection 1562 there is some mixture with *P. seorsa*.

**344. *Puccinia Vanillosmopsis* Jackson & Holway, sp. nov.**

O. Pycnidiis non visis, probaliter carentibus.

III. Teleutosoris hypophyllis, gregariis, in maculis decoloratis dense congregatis, parvis, rotundatis, 0.2–0.4 mm. diam., castaneo-brunneis, serius nudis, pulverulentis, epidermide rupta cinctis; teleutosporis late ellipsoideis,  $18\text{--}21 \times 24\text{--}30\ \mu$ , utrinque rotundatis, vix constrictis; tunica pallide castaneo-brunnea,  $2.5\text{--}3\ \mu$ , supra poros vix constrictis, minute verrucosa; poro cellulae superioris apicali, poro cellulae inferioris prope pedicellum sito; pedicello hyalino, brevissimo, deciduo.

*Vanillosmopsis erythropappa* (DC.) Sch. Bip. Petropolis, Rio de Janeiro, Brazil, Nov. 9, 1921, 1287; Tijuca, Rio de Janeiro, Brazil, Dec. 23, 1921, 1420 (type).

This species has the aspect of a micro-form, and appears to differ from other species of similar life history on related hosts.

**345. *Uredo illaudanda* Jackson & Holway, sp. nov.**

II. Uredosoris hypophyllis, sparsis vel gregariis, rotundatis, 0.2–0.4 mm. diam., tarde nudis, obscure cinnamomeo-brunneis,

pulverulentis, epidermide rupta cinctis, aparaphysatis; uredosporis late ellipsoideis vel obovatis,  $23-25 \times 29-31 \mu$ ; tunica cinnamomeo-brunnea,  $2-2.5 \mu$ , moderate minuteque echinulata, poris 3 fere aequatorialibus praedita.

*Vanillosmopsis erythropappa* (DC.) Sch. Bip. Therezopolis, Rio de Janeiro, Brazil, Oct. 4, 1921, 1192.

#### SPECIES ON VERNONIA

In the study of the Holway collections on *Vernonia* a considerable number (11) of apparently undescribed species of *Puccinia* have been encountered. Since there have been 26 species previously described on this host genus, it has seemed desirable to furnish a key to the known species, which will serve to indicate the basis on which we have separated the species which are being described as new. The writer has previously published an account of the species of *Puccinia* occurring on the Vernonieae (Bot. Gaz. 65: 289-312. 1918). A key to all the species known at that time was included (l.c., pp. 291-293). Since all of the species described in this paper fall in the smooth spored section, only the first half of the key has been revised and included here. For a key to the rough spored species, the reader is referred to the paper cited above.

#### KEY TO SPECIES OF PUCCINIA ON VERNONIA

Teliospore wall smooth or appearing so, often obscurely rugose.

Teliospore wall colorless or light cinnamon-brown, smooth.

Teliospore wall uniformly thin, rarely slightly thickened above.

Teliospores averaging more than  $60 \mu$  in length.

Aecia present in life history.

Peridium present.

Paraphyses present in the telia..... 346. *P. angitionalis*.

Paraphyses absent in the telia.

Teliospores  $12-18 \mu$  in width.

Urediniospore wall closely echinulate... 347. *P. allaudabilis*.

Urediniospore wall moderately to sparsely echinulate.. 348. *P. Becki*.

- Teliospores 18–20  $\mu$  in width.
- Urediniospores unknown; peridial cell wall rugose. . . . . *P. membranacea.*
- Urediniospores present; peridial cell wall verrucose. . . . . 354. *P. improvisa.*
- Peridium wanting; urediniospores 23–28 by 29–34  $\mu$ . . . . . *P. erratica.*
- Aecia lacking in life history or unknown.
- Teliospores averaging over 18  $\mu$  wide.
- Brachy-form; teliospores 16–24 by 56–80  $\mu$ . . . . . *P. Arthuriana.*
- Micro-form; teliospores 20–27 by 45–70  $\mu$ . . . . . *P. vernoniicola.*
- Teliospores averaging less than 18  $\mu$  wide. . . . . 353. *P. impetrabilis.*
- Teliospores averaging less than 60  $\mu$  in length.
- Teliospores less than 40  $\mu$  long. . . . . *P. Vernoniae-mollis.*
- Teliospores more than 40  $\mu$  long.
- Brachy-form; urediniospore wall 1.5–2.5  $\mu$  thick. . . . . *P. insulana.*
- Eu-form; urediniospore wall 1–1.5  $\mu$  thick. . . . . *P. fraterna.*
- Teliospores appreciably thickened above.
- Teliospore wall light-brown (South America).
- Paraphyses absent. . . . . 352. *P. illatubilis.*
- Paraphyses present.
- Paraphyses conspicuous.
- Paraphyses uniformly thin walled. . . . . 349. *P. deprecanea.*
- Paraphyses thickened on one side. . . . . 361. *P. veniabilis.*
- Paraphyses inconspicuous, thin walled.
- Urediniospores closely echinulate. . . . . 351. *P. fundata.*
- Urediniospores sparsely echinulate. . . . . 358. *P. pestibilis.*
- Teliospore wall colorless (Ceylon). . . . . *P. clara.*
- Teliospore wall dark-cinnamon or chestnut-brown, thickened at apex, in some species obscurely verrucose-rugose.
- Uredinia unknown; teliospores chestnut-brown, smooth.

- Opsis-form—(Africa) . . . . . *P. Le Testui.*  
 Micro-form—(Africa) . . . . . *P. inflorescenticola.*  
 Uredinia present; teliospores dark-cinnamon  
 or chestnut-brown, rounded below.  
 Urediniospore wall golden or cinnamon-  
 brown.  
     Urediniospore pores 4–6 scattered.  
         Teliospores averaging over 40  $\mu$   
         long.  
             Teliospore wall 3–5  $\mu$  thick.  
                 Teliospore wall light chest-  
                 nut-brown . . . . . 357. *P. pertrita.*  
                 Teliospore wall dark chest-  
                 nut-brown . . . . . 362. *P. vernoniphila.*  
                     *P. fuscella.*  
             Teliospore wall 1.5–2  $\mu$  thick.  
         Teliospores averaging less than  
         40  $\mu$  long . . . . . 350. *P. fausta.*  
     Urediniospore pores 2–3 approxi-  
     mately equatorial.  
         Teliospores averaging less than  
         60  $\mu$  long.  
             Teliospores 20–28 by 30–45  $\mu$ . *P. Vernoniae.*  
             Teliospores 21–30 by 40–60  $\mu$ . 356. *P. Lorentzii.*  
         Teliospores averaging over 60  $\mu$   
         long . . . . . 352. *P. illatabilis.*  
     Urediniospore wall colorless to faint  
     golden-brown . . . . . 360. *P. semiinsculpta.*  
 Teliospore wall prominently roughened (see Bot.  
 Gaz. 65: 292–293. 1918).

346. ***Puccinia agnitionalis*** Jackson & Holway, sp. nov.

O & I. Pycnidiis atque aecidiis praesentibus (vide argumentum).

II. Uredosoris non visis; uredosporis in teleutosoris sitis, ellipsoideis, 18–22  $\times$  26–30  $\mu$ ; tunica hyalina vel pallide aurato-brunnea, 1.5–2  $\mu$  cr., crebre minute echinulata, poris obscuris 3 pluribusve sparsis instructa.

III. Teleutosoris hypophyllis, numerosis, sparsis vel gregariis, rotundatis, 0.4–0.8 mm. diam., mox nudis, primum pallide castaneo-brunneis, deinde germinando cinerascentibus, compactis, pulvinatis; epidermide fissa inconspicua; paraphysibus copiosis, soris circumdantibus vel inter teleutosporas sparsis, clavatis, rectis vel subcurvatis, pallide cinnamomeo-brunneis, 18–24  $\mu$  latis, 125–175  $\mu$  longis, apice rotundatis, tunica uniformiter tenui 1  $\mu$  minusve praeditis; teleutosporis oblongis vel cylindraceis, depressulis, 18–20  $\mu$  vel 22–26  $\mu$  latis, diverse visis, 65–90  $\mu$  longis, infra rotundatis, supra attenuatis, e facie conspicue constrictis; tunica cinnamomeo-brunnea, aequaliter 1–

1.5  $\mu$  cr., levi; pedicello hyalino, sporam dimidiam aequante vel brevior.

*Vernonia diffusa* Less. Therezopolis, Brazil, Oct. 2, 1921, 1184.

This species is separable from other species of *Puccinia* reported on *Vernonia* by the thin teliospore walls essentially unthickened at the apex, and the presence of thin walled paraphyses accompanying the telia.

Old aecia accompanied by pycnia are present, indicating that the species is a long cycled form. The pycnia are epiphyllous, deep seated, 90–120  $\mu$  wide by 120–150  $\mu$  high, with short ostiolar filaments. The aecia are amphigenous, with well developed membranous peridia. The peridial cells were seen only in face view and are irregularly polyhedral, 16–23 by 40–50  $\mu$ . The aeciospores are ellipsoid, 18–20 by 26–30  $\mu$ , with colorless walls 1–1.5  $\mu$  thick, closely and finely verrucose.

347. *Puccinia allaudabilis* Jackson & Holway, sp. nov.

O, I. Pycnidii et aecidiis praesentibus (v. infra).

II. Uredosoris hypophyllis, paucis, sparsis, rotundatis, 0.5–1 mm. diam., pallide cinnamomeo-brunneis, mox nudis, pulverulentis, epidermide rupta inconspicuis; uredosporis globoideis vel late ellipsoideis, 20–24  $\times$  22–26  $\mu$ ; tunica tenui 1.5–2  $\mu$ , crebre tenuiter echinulata; poris subobscuris, 3–4, sparsis.

III. Teleutosoris hypophyllis, copiosis, sparsis vel gregariis, parvis, 0.5–0.8 mm. diam., mox nudis, pulvinatis, castaneo-brunneis, germinando cinerascens, epidermide rupta plerumque inconspicuis, paraphysatis; teleutosporis cylindratis vel teretibus, 15–19  $\times$  60–78  $\mu$ , infra ad pedicellum rotundatis vel contractis, ad apicem obtusis vel paulatim angustatis, leniter vel non constrictis; tunica cinnamomeo-brunnea, uniformiter tenui, 1–1.5  $\mu$ , levi; pedicello hyalino, fragili, sporam aequante vel brevior.

*Vernonia argyrotrichia* Sch. Bip. Therezopolis, Rio de Janeiro, Brazil, Oct. 8, 1921, 1199 (type); Oct. 11, 1921, 1212.

This species may be distinguished from others on *Vernonia* by the slender, thin walled teliospores, not thickened at the apex and not over 20  $\mu$  wide, together with the thin walled, closely echinulate urediniospores.

A few old aecia accompanied by pycnia are present, but are too imperfect for adequate diagnosis. The pycnia are epiphyllous, deep seated, nearly globoid, 120–150  $\mu$  wide by 150  $\mu$  high, with short ostiolar filaments. The aecia are hypophyllous, with membranous, lacerate peridium. The peridial cells seen in face view are irregularly polyhedral, 23–28 by 40–60  $\mu$ . The wall is coarsely and prominently tuberculate verrucose. The aeciospores are ellipsoid, 20–30 by 24–26  $\mu$ , with colorless thin walls, 1–1.5  $\mu$ , coarsely and prominently verrucose, with a tendency to be verrucose rugose near one end.

348. PUCCINIA BECKI Mayor, Mém. Soc. Neuch. Sci. Nat. 5: 509. 1913.

*Vernonia arborescens* Sw. Huigra, Chimborazo, Ecuador, Aug. 6, 1920, 848.

*Vernonia argyrotrichia* Sch. Bip. Reserva Florestal, Itatiaia, Rio de Janeiro, Brazil, May 9, 1922, 1832.

The collections listed are referred to *P. Becki* tentatively. Neither agrees perfectly with the type, though both have long narrow teliospores not thickened at the apex. The collection on *V. arborescens* differs in having larger, thicker walled urediniospores and teliospores which reach a maximum length of 100  $\mu$ . The collection on *V. argyrotrichia* is quite different from one on the same host referred to *Puccinia allaudabilis* Jackson & Holway. In the latter collection the urediniospore markings are closely placed and the teliospores reach a maximum length of 78  $\mu$ . In the collection referred here, the urediniospore markings are moderately to sparsely placed and the teliospores average over 75  $\mu$  in length and reach a maximum of 120  $\mu$ .

*P. Becki* was described from a collection made in Colombia on *V. Cotoneaster*, which bore uredinia and telia only. Both collections listed above bear aecia. A collection made in Jamaica and referred to *P. Becki* by the writer (Bot. Gaz. 65: 293. 1918) also bore aecia.

It seems probable that there may be several long cycled species having long narrow teliospores unthickened at the apex and not accompanied by paraphyses, separable primarily on aecial and uredinal characters. We hesitate, however, to describe either

of the above collections as new. More ample material on a number of hosts will be needed before specific limits can be determined in this group of *Vernonia* rusts.

349. ***Puccinia deprecanea*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, paucis, punctiformibus, profunde insidentibus, ampullaceis, 85–95  $\mu$  latis, 110–125  $\mu$  altis; periphysibus prominentibus.

I. Aecidiis amphigenis, paucis 1–6, circum pycnidia in maculis decoloratis dense aggregatis; peridio delicato, albo, lacerato, mox scissili; cellulis peridialibus e facie irregulariter polygonis, 20–23  $\times$  26–30  $\mu$ , tunica minute crebreque verrucoso-tuberculata vel verrucoso-rugosa; aecidiosporis globosis vel late ellipsoideis, 20–24  $\times$  26–30  $\mu$ ; tunica hyalina, 1.5–2.5  $\mu$ , minute crebreque verrucoso-tuberculata, rugoso-striata, striam uno latere efformante.

II. Uredosoris hypophyllis, sparsis vel gregariis, parvis, rotundatis, 0.2–0.5 mm. diam., cinnamomeo-brunneis, mox nudis, pulverulentis, epidermide rupta inconspicuis; paraphysibus copiosis, soro circumdantibus, cylindraceis vel clavatis, parum incurvatis, 20–30  $\times$  110–175  $\mu$ , supra rotundatis sed infra attenuatis, tunica uniformiter tenui 1  $\mu$  minusve praeditis; uredosporis obovatis, 20–23  $\times$  23–28  $\mu$ , tunica incolori tenui 1–1.5  $\mu$  minute moderateque echinulata et poris obscuris instructis.

III. Teleutosoris hypophyllis, uredosoris conformibus sed pulvinatis, castaneo-brunneis, e germinatione cinereis; paraphysibus uredosoris conformibus; teleutosporis oblongis vel clavatis, 20–26  $\times$  50–65  $\mu$ , supra rotundatis, infra rotundatis vel pedicellum versus contractis, leniter vel non constrictis; tunica tenui, 1–1.5  $\mu$ , septo loculi inferioris et utroque latere pori generativi apice ad 4  $\mu$  incrassata, levi; pedicello hyalino, brevi, deciduo.

*Vernonia* sp. Juquery, São Paulo, Brazil, June 12, 1922, 1962.

This species is easily distinguished from other *Vernonia* rusts by the presence of abundant, conspicuous thin walled paraphyses, and the thin walled light colored teliospores appreciably thickened at the apex.

350. ***Puccinia fausta*** Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis vel saepius gregariis, rotundatis, 0.3–0.5 mm. diam., mox nudis, pulverulentissimis, cinnamomeo-brunneis; epidermide rupta inconspicua; uredosporis globosis, ellipsoideis vel obovoideis, 20–22  $\times$  24–28  $\mu$ ; tunica



hyalina vel pallide aurato-brunnea, 2–2.5  $\mu$  cr., minute subsparsae echinulatae; poris obscuris, 4–6, sparsis.

III. Teleutosoris non visis; teleutosporis in uredosoris sitis, late ellipsoideis, 27–30  $\times$  35–40  $\mu$ , utrinque rotundatis, septo non constrictis; tunica castaneo-brunnea, 3–4  $\mu$  cr., supra poros leniter incrassata ad 5–6  $\mu$ , obscurissime verrucoso-rugosa sed apparenter levi, pedicello hyalino brevi deciduo et poro cellulae inferioris mediano praedita.

*Vernonia macrophylla* Less. Therezopolis, Rio de Janeiro, Brazil, Oct. 13, 1921, 1216.

This species is separable from *P. inaequata* by the nearly smooth walled teliospores and the scattered uredinial pores.

351. *Puccinia fundata* Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis, parvis, rotundatis. 0.4–0.8 mm. diam., pallide cinnamomeo-brunneis, mox nudis, pulverulentis; epidermide rupta inconspicua; paraphysibus inconspicuis, numerosis, soro circumdantibus, rectis vel incurvatis, 15–20  $\times$  60–90  $\mu$ ; tunica hyalina vel leniter tincta, uniformiter tenui 1  $\mu$  minusve; uredosporis obovatis vel late ellipsoideis, 19–23  $\times$  26–30  $\mu$ ; tunica tenui, 1–1.5  $\mu$ , hyalina vel pallidissime aurato-brunnea, creberrime et minutissime echinulata, poris obscuris praedita.

III. Teleutosoris hypophyllis, sparsis vel gregariis, parvis, rotundatis, 0.2–0.5 mm. diam., mox nudis, primum pallide castaneo-brunneis, deinde germinando cinereis, compactis, pulvinatis; epidermide rupta inconspicua; paraphysibus uredoso conformibus; teleutosporis clavatis vel late ellipsoideis, 24–28  $\times$  44–65  $\mu$ , supra rotundatis, infra rotundatis vel angustatis, leniter vel non constrictis; tunica tenui 1–1.5  $\mu$ , cinnamomeo-brunnea, septo apiceque incrassata ad 6–9  $\mu$ , levi; pedicello hyalino, fragili, sporam aequante vel brevior.

*Vernonia discolor* (Spreng.) Less. Rio de Janeiro, Brazil, Nov. 12, 1921, 1294 (type).

*Vernonia* sp. Petropolis, Rio de Janeiro, Brazil, Oct. 30, 1921, 1261.

Distinguishable from other *Vernonia* rusts by the presence of thin walled paraphyses and thin walled light colored teliospores broadly thickened at apex.

352. *Puccinia illatabilis* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, paucis, gregariis, areas decoloratas subhypertrophicis occupantibus, punctiformibus, profunde in-

sidentibus, ellipsoideis, 110–125  $\mu$  latis, 135–150  $\mu$  altis; periphysibus non prominentibus.

I. Aecidiis epiphyllis, paucis, magnis, 0.25–0.4 mm. diam., profunde insidentibus; peridio cylindraceo vel saccato, firmo, albo; cellulis peridialibus e facie 20–28  $\times$  36–54  $\mu$ ; tunica minute crebreque verrucosa; aecidiosporis irregulariter ellipsoideis vel globoideis, 20–23  $\times$  24–48  $\mu$ ; tunica pallide aurato-brunnea, 1.5–2  $\mu$  cr., una fine ad 3–5  $\mu$  incrassata, crassius crebrius verrucoso-tuberculata, verrucis incrassata fine prominulioribus.

II. Uredosoris hypophyllis, sparsis, parvis, rotundatis, 0.2–0.4 mm. diam., tardius nudis, cinnamomeo-brunneis, pulverulentis, epidermide rupta cinctis, aparaphysatis; uredosporis ellipsoideis vel obovatis, 21–24  $\times$  26–30  $\mu$ ; tunica obscure cinnamomeo- vel pallide castaneo-brunnea, 1.5–2  $\mu$  cr., minute crebriusque echinulata; poris 3, fere aequatorialibus.

III. Teleutosoris hypophyllis, sparsis, parvis, rotundatis, 0.2–0.3 mm. diam., mox nudis, castaneo-brunnea, pulvinatis; epidermide rupta plerumque inconspicua; teleutosporis ellipsoideis, cylindraceis vel clavatis 15–24  $\times$  54–90  $\mu$ , infra rotundatis vel angustatis, supra rotundatis vel obtusis, plerumque conspicue constrictis; tunica cinnamomeo- usque castaneo-brunnea, 1–1.5  $\mu$  cr., apice ad 6–12  $\mu$  visibiliter incrassata; pedicello hyalino, sporam subaequante.

*Vernonia scorpioides* Pers. Coroico, Nor Yungas, Bolivia, June 11, 1920, 729.

Distinguished from other *Vernonia* rusts by the epiphyllous aecia, the long narrow teliospores strongly thickened above and the entire absence of paraphyses. The teliospores are much like those of *P. veniabilis*. The pore of the upper cell is at one side of the thickened apex and that of the lower cell at the septum is not in line with the upper pore but in a plane at right angles so that the two pores are not in view at the same time.

353. *Puccinia impetrabilis* Jackson & Holway, sp. nov.

II. Uredosoris amphigenis sed plerumque hypophyllis, sparsis, rotundatis, 0.5–0.8 mm. diam., mox nudis, cinnamomeo-brunneis, pulverulentis, epidermide rupta plerumque cinctis; uredosporis late ellipsoideis vel globosis, 26–28  $\times$  28–32  $\mu$ ; tunica pallide cinnamomeo-brunnea vel subhyalina, 3–4  $\mu$  cr., valde sparseque echinulata, poris obscuris instructa.

III. Teleutosoris hypophyllis, paucis, sparsis, rotundatis, parvis, 0.4–0.6 mm. diam., mox nudis, compactis, pulvinatis, pallide castaneo-brunneis, germinando cinerascentibus; epider-

mide rupta non visibili; teleutosporis cylindraceis,  $15-18 \times 65-95 \mu$ , basi truncatis, apice obtusis vel teretibus, vix constrictis; tunica cinnamomeo-brunnea, tenui  $1-1.5 \mu$ , apice non incrassata, levi; pedicello hyalino, fragili, sporam aequante vel brevior.

*Vernonia sericea* Rich. Rio de Janeiro, Brazil, Nov. 12, 1921, 1295.

*Vernonia* sp. Therezopolis, Rio de Janeiro, Brazil, Oct. 15, 1921, 1222; Petropolis, Rio de Janeiro, Nov. 1, 1921, 1265 (type).

This species is somewhat like *P. erratica* Jackson & Holway, but may be distinguished from it and all others by the narrow teliospores and the very thick walled, sparsely echinulate urediniospores and the absence of paraphyses. In the collection on *V. sericea* the urediniospore wall is not quite so thick as described. The collection is referred to this species provisionally.

354. ***Puccinia improvisa*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, paucis 2-5. in areis decoloratis subhypertrophicis crebre aggregatis, punctiformibus, profunde insidentibus, subglobois,  $140-150 \mu$  diam.; periphysibus brevibus.

I. Aecidiis hypophyllis, pycnidiis contrappositis, paucis 2-5, magnis,  $0.2-0.4$  mm. diam.; peridio conspicue adulto, cylindraceo vel saccato, albo vel flavescenti; loculis peridialibus e facie irregulariter polygonis,  $20-26 \times 45-60 \mu$ ; tunica crebre minuteque sed prominenter verrucosa; aecidiosporis late ellipsoideis, saepe fine superiore obtusis vel subacutis,  $22-26 \times 30-36 \mu$ ; tunica hyalina,  $2-3 \mu$  cr., prominenter sed minute verrucoso-tuberculata.

II. Uredosoris plerumque hypophyllis, paucis, sparsis vel gregariis, rotundatis,  $0.5-1.0$  mm. diam., mox nudis, cinnamomeo-brunneis, pulverulentis, epidermide rupta plerumque cinctis, paraphysatis; uredosporis late ellipsoideis vel obovoideis,  $24-28 \times 28-32 \mu$ ; tunica pallide cinnamomeo-brunnea vel fere hyalina,  $2-3 \mu$  cr., prominenter sparsiusque echinulata, poris obscuris instructa.

III. Teleutosis hypophyllis, numerosis, sparsis vel gregariis, rotundatis, parvis,  $0.2-0.5$  mm. diam., mox nudis, castaneo-brunneis, ob germinationem cinerascentibus; epidermide rupta non visibili; teleutosporis ellipsoideis, oblongis vel cylindraceis,  $18-26 \times 58-88 \mu$ , infra rotundatis, supra rotundatis vel obtusis, septo leniter constrictis; tunica cinnamomeo-brunnea, uniformiter tenui,  $1-1.5 \mu$ , levi; pedicello hyalino, sporam aequante vel brevior.

*Vernonia eriolepis* Gardn. Reserva Florestal, Itatiaya, Rio de Janeiro, Brazil, May 9, 1922, 1836.

*Vernonia subsquarrosa* DC. Rio de Janeiro, Brazil, Aug. 13, 1921, 1030; Aug. 23, 1921, 1064 (type).

This species is somewhat like *P. impetrabilis* Jackson & Holway, differing in the length and width of the teliospores and in the shape. In this species the apex is usually rounded, while in the *P. impetrabilis* the upper cell usually tapers gradually to the apex.

A comparison has been made with *P. membranacea* Dietel. Our species differs markedly in the size and character of the aecia. In *P. membranacea* the peridium is lacerate, not highly developed, and the wall markings are distinctly rugose.

The collection on *V. eriolepis* is placed here provisionally. The aeciospores are somewhat more strongly marked and it may prove to be better assigned elsewhere. The teliospores are narrower and more like those of *P. allaudabilis*, but the urediniospores correspond better with this species.

355. PUCCINIA INAEQUATA Jackson & Holway; Arth. Bot. Gaz. 65: 309. 1918.

*Bullaria inaequata* Arth. & Mains, N. Am. Fl. 7: 498. 1922.

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*Vernonia paludosa* Gardn. Campos do Jordão, São Paulo, Brazil, Apr. 23, 1922, 1757; Apr. 28, 1922, 1783, 1785.

*Vernonia patens* H.B.K. Huigra, Chimborazo, Ecuador, Aug. 6, 1920, 853.

*Vernonia Westiniana* Less. Campos do Jordão, São Paulo, Brazil, Apr. 21, 1922, 1750; Garulhos, São Paulo, Brazil, June 1, 1922, 1931; Curityba, Brazil, June 20, 1922, 1974.

*Vernonia* (Near *V. Beyrichii* Less.) Garulhos, São Paulo, Brazil, June 1, 1922, 1932.

This species has previously been reported only from Guatemala on *Vernonia patens*. Of the collections reported above, only the one from Ecuador is on the type host. The collections on *V. paludosa* are referred here provisionally. The urediniospores are smaller and the markings more closely echinulate. The teliospore wall is lighter colored and the markings are often

absent in the lower part of the spore. One collection (1757) shows old primary uredinia, indicating the same life history as *P. inaequata*, and we hesitate to separate it. The collections on *V. Westiniana* also have smaller urediniospores, but the telia are remarkably like those of the type collection.

The species may be separated from all others on *Vernonia* by the small teliospores having evident verrucose-rugose markings on the wall.

356. *PUCCINIA LORENTZII* P. Henn. *Hedwigia* **35**: 239. 1896.

*Vernonia scorpioides* (Lam.) Pers. Rio de Janeiro, Brazil, Aug. 9, 1921, 1004; Fonseca, Nictheroy, Brazil, Sept. 18, 1921, 1122; Petropolis, Rio de Janeiro, Brazil, Oct. 18, 1921, 1228; São Paulo, Brazil, Jan. 23, 1922, 1493.

*Vernonia scorpioides sororia* (DC.) Baker, Reserva Florestal, Itatiaya, Rio de Janeiro, Brazil, May 8, 1922, 1825.

The collections listed bear uredinia only, and the spores are alike in all of them. *P. Lorentzii* has been recorded primarily from Brazil and Argentina on this host, and it has seemed best to refer the collections to that species for the present.

357. *Puccinia pertrita* Jackson & Holway, sp. nov.

II. Uredosoris amphigenis, plerumque hypophyllis, numerosis, sparsis, rotundatis, 0.3–0.5 mm. diam., cinnamomeo-brunneis, tardius nudis, pulverulentis, epidermide rupta cinctis; uredosporis globosis, 22–26  $\mu$  diam.; tunica cinnamomeo-brunnea, 1.5–2  $\mu$ , minute crebreque echinulata; poris 4–6, sparsis.

III. Teleutosoris uredosoris conformibus, atro-brunneis; teleutosporis late ellipsoideis vel oblongis, 30–36  $\times$  45–60  $\mu$ , infra rotundatis, supra rotundatis vel umbonatis, plerumque septo leniter constrictis; tunica obscure castaneo-brunnea, 3–5  $\mu$  cr., supra poros ad 6–8  $\mu$  umbone pallidiore incrassata, obscure verrucoso-rugosa, apparenter tereti, pedicello hyalino brevi deciduo praedita.

*Vernonia cognata* Less. Summit of Jaragua, near Taipas, São Paulo, Brazil, Feb. 19, 1922, 1572; Villa Prudente, São Paulo, Brazil, June 9, 1922, 1944.

*Vernonia lessingioides* Sch. Bip. Santa Anna, São Paulo, Brazil, May 28, 1922, 1901 (type).

*Vernonia* sp. Campos do Jordão, São Paulo, Brazil, Apr. 27, 1922, 1778.

Separable from other species on *Vernonia* by the large thick walled teliospores, the walls of which are essentially smooth, and large globose urediniospores with scattered pores and with walls nearly colorless, thin and finely and closely echinulate. The species differs from our interpretation of *P. vernoniphila* Speg. in urediniospore characters and from *P. pinguis* in the essentially smooth teliospore walls.

358. ***Puccinia pestibilis*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, paucis, dense aggregatis, punctiformibus, ampullaceis, profunde insidentibus, 105–120  $\mu$  latis, 120–150  $\mu$  altis; periphysibus brevibus.

I. Aecidiis epiphyllis, dense gregariis, pycnidia circumdantibus, paucis, parvis; peridio conspicue adulto, lacerato, albo; cellulis peridialibus e facie irregulariter polygonis, 20–28  $\times$  45–60  $\mu$ ; tunica prominenter verrucoso-rugosa; aecidiosporis late ellipsoideis, 20–24  $\times$  30–36  $\mu$ , pariete incolori 1.5–2  $\mu$  cr. prominenter verrucoso-tuberculato praeditis.

II. Uredosoris hypophyllis, sparsis, rotundatis, 0.5–0.8 mm. diam., mox nudis, pallide cinnamomeo-brunneis, pulverulentis, epidermide rupta inconspicuis; paraphysibus praesentibus, inconspicuis, paucis, hyalinis vel leniter tinctis, rectis vel curvatis, 12–15  $\times$  40–50  $\mu$ , tunica uniformiter tenui praeditis; uredosporis obovatis 22–27  $\times$  28–34  $\mu$ ; tunica, 1.5–2.5  $\mu$  cr., hyalina vel pallide aurato-brunnea, sparsius prominenterque echinulata; poris obscuris, 4–6, sparsis.

III. Teleutosoris hypophyllis, sparsis vel gregariis, parvis, rotundatis, 0.2–0.5 mm. diam. mox nudis, castaneo-brunneis, germinando cinerascentibus, pulvinatis; epidermide rupta inconspicua; paraphysibus uredosoris conformibus; teleutosporis late ellipsoideis vel obovatis, 23–30  $\times$  50–80  $\mu$ , supra rotundatis vel obtusis, infra rotundatis vel angustatis, septo leniter constrictis; tunica lateribus tenui, 1–1.5  $\mu$ , pallide cinnamomeo-brunnea, septo cellulae inferioris et apice ad 4–10  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel brevior.

*Vernonia oppositifolia* Less. Rio de Janeiro, Brazil, Aug. 14, 1921, 1036; Therezopolis, Rio de Janeiro, Brazil, Sept. 29, 1921, 1168; Petropolis, Brazil, Oct. 20, 1921, 1233 (type).

This species is one of a group having light colored, smooth teliospore walls, thickened at the apex. It differs from *P. fundata* in the character of the markings of the urediniospores and from *P. deprecanea* in aeciospore characters, and in the absence of

conspicuous paraphyses. The latter are present, but very poorly developed.

359. PUCCINIA ROTUNDATA Dietel, Hedwigia **36**: 32. 1897.

*Puccinia rugosa* Speg. Ann. Soc. Cient. Argent. **17**: 92. 1884.  
(Not Billings 1871.)

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*Vernonia ferruginea* Less. Bello Horizonte, Minas Geraes, Brazil, Nov. 23, 1921, 1327; Sabará, Minas Geraes, Brazil, Dec. 2, 1921, 1363.

*Vernonia missionis* Gardn. Rio de Janeiro, Brazil, Aug. 12, 1921, 1024.

*Vernonia petiolaris* DC. Cantareira, São Paulo, Brazil, May 30, 1922, 1920.

*Vernonia petiolaris appendiculata* Baker, Reserva Florestal, Itatiaya, Rio de Janeiro, Brazil, May 6, 1922, 1809.

*Vernonia Westiniana* Less. São Paulo, Brazil, Jan. 26, 1921, 1501; Campos do Jordão, São Paulo, Brazil, Apr. 23, 1922, 1760.

*Vernonia* sp. Alta Boa Vista, Rio de Janeiro, Sept. 17, 1921, 1119; Fonseca, Nictheroy, Rio de Janeiro, Brazil, Sept. 18, 1921, 1125; Campo Grande, Rio de Janeiro, Brazil, Sept. 19, 1921, 1130; Therezopolis, Rio de Janeiro, Brazil, Sept. 28, 1921, 1162, 1165; Petropolis, Rio de Janeiro, Brazil, Oct. 18, 1921, 1229; Ouro Preto, Minas Geraes, Brazil, Dec. 7, 1921, 1370; Barbacena, Minas Geraes, Brazil, Dec. 12, 1921, 1386; Novo Friburgo, Rio de Janeiro, Brazil, Jan. 2, 1922, 1442; Alto da Serra, São Paulo, Brazil, Jan. 28, 1922, 1507.

This characteristic micro-form seems to have a wide distribution in South America, and is also known from Costa Rica and Panama.

360. PUCCINIA SEMIINSCULPTA Arth. Bot. Gaz. **40**: 204. 1905.

*Bullaria semiinsculpta* Arth. & Mains, N. Am. Fl. **7**: 498. 1922.

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*Vernonia barbanoides* Less. Villa Prudente, São Paulo, Brazil, June 5, 1922, 1943.

*Vernonia obscura* Less. Mandaque, São Paulo, Brazil, May 25, 1922, 1890; Mogy das Cruzes, São Paulo, Brazil, July 4, 1922, 2002.

The collections listed seem best referred to *P. semiinsculpta* for the present. All the collections bear telia only, which are chiefly epiphyllous. The spores correspond very closely with the thick walled form of this species. Only a few urediniospores were found, which seem to conform with the description. The species has hitherto been known only from Mexico.

361. ***Puccinia veniabilis*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, paucis, in maculis parum decoloratis crebre gregariis, punctiformibus, profunde insidentibus, ellipsoideis, 75-90  $\mu$  latis, 100-135  $\mu$  altis; periphysibus brevibus.

I. Aecidiis hypophyllis, singulatim vel in greges 2-4 dispositis, pycnidiis contrappositis; peridio conspicue adulto, albo, membranaceo, breviter, cylindraceo vel saccato; margine lacerato; loculis peridialibus e facie polygonis, 20-30  $\times$  45-60  $\mu$ , tunica tenui minute verrucosa praeditis; aecidiosporis ellipsoideis 20-24  $\times$  28-36  $\mu$ ; tunica hyalina vel pallide aurato-brunnea, 1.5-2  $\mu$  cr., valde verrucoso-tuberculata, saepe striata, dein finem versus rugoso-striata.

II. Uredosoris non visis; uredosporis in teleutosoris globosis, 22-28  $\mu$  latis; tunica 1.5-2.5  $\mu$  cr., pallide cinnamomeo-brunnea, moderate valdeque echinulata; poris obscuris, 3-4, sparsis.

III. Teleutosoris hypophyllis, sparsis vel gregariis, parvis, rotundatis, 0.2-0.4 mm. diam., mox nudis, compactis, pulvinatis, primum castaneo-brunneis, deinde germinatione cinereis; paraphysibus copiosis, conspicuis, soro circumdantibus, valde arcuatis, septatis 2-3, 12-15  $\times$  60-100  $\mu$ , apice obtuso; tunica cinnamomeo-brunnea, exteriore 5-8  $\mu$  cr., interiore 1-1.5  $\mu$ ; teleutosporis cylindraceis, 17-24  $\times$  60-100  $\mu$ , basi rotundatis vel truncatis, apice rotundatis vel saepius acutis, septo non vel leniter contractis; tunica cinnamomeo- vel pallide castaneo-brunnea, 1-1.5  $\mu$  cr., angulis cellulae inferioris visibiliter et apice magnopere ad 15  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel brevior.

*Vernonia* sp. Therezopolis, Rio de Janeiro, Brazil, Oct. 4, 1921, 1189 (type); Santo Amaro, São Paulo, Brazil, March 16, 1922, 1639; May 27, 1922, 1894; Bosque da Saude, São Paulo, Brazil, May 27, 1922, 1896.

A very distinct species among *Vernonia* rusts, characterized



by the long narrow teliospores, greatly thickened at the apex, and the strongly developed, thick walled, incurved paraphyses. The thickening at the apex of the teliospore wall is usually much stronger on one side of the germ pore.

362. *PUCCINIA VERNONIPHILA* Speg. Ann. Mus. Buenos Aires 19: 306. 1909.

*Vernonia glabrata* Less. Santo Amaro, São Paulo, Brazil, March 16, 1922, 1637, May 27, 1922, 1895.

*Vernonia squarrosa* Less. Santa Anna, São Paulo, Brazil, May 28, 1922, 1898.

*Vernonia* sp. Mandaque, São Paulo, Brazil, May 25, 1922, 1885.

*Puccinia Vernoniphila* Speg. was based on a collection made at Buenos Aires, Argentina, on *Vernonia flexuosa*. Telia only were described. We have examined a portion of the type collection and can find no urediniospores. The aspect, however, is not that of a micro-form.

The above listed collections are assigned to this species with some hesitation, and the identification is tentative. Uredinia are present in our material. The urediniospores are globoid, 22–28  $\mu$  in diameter, the wall is minutely and closely echinulate, 2–3  $\mu$  thick, and the pores are 4–6 scattered. The teliospores agree very well with those in the type collection, although in No. 1898 they are somewhat more regular and broader with the wall slightly thicker and more prominently marked. Until other collections from the type locality are available, the exact status of this species must remain in doubt.

#### SPECIES ON CARDUACEAE

##### (Tribe Eupatorieae)

363. *AECIDIUM AMPLIATUM* Jackson & Holway; Arth. Mycologia 10: 148. 1918.

*Eupatorium lasiophthalmum* Griseb. Cochabamba, Bolivia, March 11, 1920, 396.

This collection seems best referred to this species for the present, though differing slightly in spore size and character of peridial cells. It is too close to justify separation. The type

collection was made at El Alto, Cartago, Costa Rica, Jan. 16, 1916, by Holway (434), and has not been reported elsewhere.

364. *Aecidium minimum* Jackson & Holway, sp. nov.

O. Pycnidiis amphigenis, profunde insidentibus, punctiformibus, in maculis decoloratis dense gregariis, globosis vel ellipsoideis  $90\text{--}120 \times 90\text{--}120 \mu$ ; periphysibus brevibus.

I. Aecidiis hypophyllis, numerosis, dense gregariis, in greges 5–8 mm. diam. maculis decoloratis saepe purpurascentibus insidentibus, parvis, rotundatis,  $200\text{--}275 \mu$  diam., cupulatis, peridio pallide flavo et margine revoluto lacerato praeditis; cellulis peridialibus e latere rhomboideis,  $12\text{--}16 \times 28\text{--}34 \mu$ , subforte imbricatis; tunica exteriori  $2.5\text{--}4 \mu$  cr., levi, interiori  $2\text{--}2.5 \mu$ , crebre prominenterque verrucosa; aecidiosporis subglobosis,  $12\text{--}15 \mu$  diam., tunica hyalina  $1 \mu$  minusve cr. tenuiter crebreque verrucosa praeditis.

*Stevia urticaefolia* Thunb. Ouro Preto, Minas Geraes, Brazil, Dec. 6, 1921, 1366 (type); Hacienda La Florida, Sur Yungas, Bolivia, May 27, 1920, 665.

This *Aecidium* is very much like the aecial stage of *Puccinia Eleocharidis* Arth., which occurs on species of *Eupatorium*. The aeciospores in our specimens are, however, noticeably smaller. Since the diplont of *P. Eleocharidis* has not with certainty been reported from South America, we hesitate to record it under that species.

365. *CHRYSOCYCLUS MIKANIAE* (Arth.) Sydow, Ann. Myc. 23: 324. Dec. 31, 1925.

*Puccinia subandina* Lagerh. ined. (Not Speg. 1902.)

*Chrysopsora Mikaniae* Arth. Bull. Torrey Club 51: 54. 1924.

*Holwayella Mikaniae* Jackson, Mycologia 18: 49. Jan. 1, 1926.

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*Mikania buddleiaefolia* DC. San Felipe, Sur Yungas, Bolivia, May 21, 1920, 637; Therezopolis, Rio de Janeiro, Brazil, Sept. 28, 1921, 1159 (type).

*Mikania Lindbergii* Bak. Mandaque, São Paulo, Brazil, May 25, 1922, 1884; Tremembé, São Paulo, Brazil, May 30, 1922, 1910.

The Brazilian collection on *Mikania buddleiaefolia* is the type of this interesting species. In this collection the two celled

*Puccinia*-like stage is of short duration, while in the Bolivian material an evident two celled stage is developed. It is possible that more than one species occurs on *Mikania*, but at this time we hesitate to attempt a separation of the material. A specimen labelled *Puccinia subandina* Lagerh. n. sp., collected by Lagerheim, Oct. 1891, in Ecuador, is in the Arthur Herbarium, and is similar to the Bolivian collection recorded above. The name seems never to have been published.

366. **Cionothrix andina** (Lagerh.) Jackson & Holway, comb. nov.

*Cronartium andinum* Lagerh. Sydow, Monog. Ured. 3: 581. 1915.

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*Eupatorium Pseudochila* Benth. Quito, Ecuador, Aug. 16, 1920, 906.

A characteristic species apparently previously known only from the type collection made by Lagerheim at Pichincha, Ecuador. The telial columns in this species are broader, the color darker and the spores considerably larger than in the more common *C. praelonga*.

367. **CIONOTHRIX PRAELONGA** (Wint.) Arth. N. Am. Fl. 7: 124. 1907.

*Cronartium praelongum* Wint. Hedwigia 26: 24. 1887.

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*Eupatorium subscandens* Hieron. El Chaco, Sur Yungas, Bolivia, May 25, 1920, 646.

*Eupatorium* sp. Ouro Preto, Minas Geraes, Brazil, Dec. 9, 1921, 1373; São João, São Paulo, Brazil, Apr. 13, 1922, 1729.

368. **PUCCINIA CONOCLINII** Seym.; Burrill, Bot. Gaz. 9: 191. 1884.

*Uredo Agerati* Mayor, Mém. Soc. Neuch. Sci. Nat. 5: 595. 1913.

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*Ageratum conyzoides* L. Huigra, Chimborazo, Ecuador, Aug. 6, 1920, 851; Hacienda La Florida, Sur Yungas, Bolivia, May 26, 1920, 658; Hacienda Anacuri, Nor Yungas, Bolivia, June 5, 1920, 723.

*Eupatorium Bridgesii* Rob. Cochabamba, Bolivia, March 7, 1920, 373.

*Eupatorium pseudoriganoides* Hieron. Cuenca, Azuay, Ecuador, Sept. 15, 1920, 993.

*Eupatorium Solidaginifolium* H.B.K. Huigra, Chimborazo, Ecuador, Aug. 5, 1920, 845.

*Eupatorium urubambense* Rob. Urubamba Valley, Peru, July 3, 1920, 759.

369. PUCCINIA EUPATORII Dietel, Hedwigia 36: 32. 1897.

*Eupatorium betonicaeforme* (DC.) Bak. Summit of Jaraguá, Near Taipas, São Paulo, Brazil, Feb. 19, 1922, 1573; São Caetano, São Paulo, Brazil, Feb. 22, 1922, 1586.

*Eupatorium macrocephalum* Less. Arthur Anvim, São Paulo, Brazil, March 15, 1922, 1632; Santa Anna, São Paulo, Brazil, Feb. 22, 1922, 1588; Campinas, São Paulo, Brazil, Apr. 5, 1922, 1701; Lapa, São Paulo, Brazil, March 3, 1922, 1606.

*Eupatorium pumilum* (Gardn.) Rob. Campos do Jordão, São Paulo, Brazil, Apr. 24, 1922, 1764.

*Eupatorium purpurascens* Sch. Bip. Reserva Florestal, Itatiaya, Rio de Janeiro, Brazil, May 7, 1922, 1821; Garulhos, São Paulo, Brazil, June 1, 1922, 1928; Santa Amaro, São Paulo, Brazil, June 26, 1922, 1984.

*Eupatorium* sp. Santa Amaro, São Paulo, Brazil, June 26, 1922, 1982; Mandaque, São Paulo, Brazil, May 25, 1922, 1892.

Originally reported from Serra Geral, Brazil on *Eupatorium macrocephalum*, this species is also known from Uruguay, Argentina, Colombia and Trinidad.

370. PUCCINIA EUPATORII-COLUMBIANI Mayor, Mém. Soc. Neuch. Sci. Nat. 5: 514. 1913.

*Eupatorium adenanthum* DC. Petropolis, Brazil, Oct. 20, 1921, 1236.

*Eupatorium inulaefolium* H.B.K. Nictheroy, Rio de Janeiro, Brazil, Dec. 27, 1921, 1428; Botanical Garden, São Paulo Museum, São Paulo, Brazil, March 13, 1922, 1626; Reserva Florestal, Itatiaya, Rio de Janeiro, Brazil, May 7, 1922, 1816.

*Eupatorium inulaefolium suaveolens* (H.B.K.) Hieron. Hacienda Anacuri, Nor Yungas, Bolivia, June 3, 1920, 704; Hacienda La Florida, Sur Yungas, Bolivia, May 28, 1920, 670.

*Eupatorium* sp. Guaruja, São Paulo, Brazil, June 12, 1922, 2007; Raiz da Serra, Petropolis, Brazil, Nov. 6, 1921, 1279; Jacarépaguá, Rio de Janeiro, Brazil, Nov. 16, 1921, 1311.

A characteristic species originally reported on *Eupatorium columbianum* from Colombia. It has also been reported from Trinidad on *E. inulaefolium*.

371. *PUCCINIA HORRIDA* Lagerh.; Pat. & Lagerh. Bull. Soc. Myc. Fr. 11: 214. 1895.

*Eupatorium cacalioides* H.B.K. Cuenca, Azuay, Ecuador, Sept. 10, 1920, 970.

This very characteristic species seems not to have been reported except from the type locality at Guaranda, Ecuador.

372. *Puccinia Mikaniae* Jackson & Holway, sp. nov.

O. Pycnidiis non visis.

I. Aecidiis hypophyllis, in greges 2-3 mm. diam. laxe gregariis, parvis, cupulatis, peridio flavescenti et margine revoluta vel eroso praeditis; cellulis peridialibus e latere rhomboideis, 14-16  $\times$  28-32  $\mu$ , subforte imbricatis; tunica exterior 4-6  $\mu$  cr., transverse striata, interiore 2-3  $\mu$ , minute crebreque verrucosa; aecidiosporis angulato-globosis, 15-18  $\mu$  diam., tunica hyalina 1  $\mu$  minute verrucosa praeditis.

III. Teleutosoris hypophyllis, inter vel circum aecidia dispositis, crebre gregariis et plus minusve in greges 2-5 mm. diam. confluentibus, tarde nudis, nigrescentibus, compactis, applanatis, epidermide diu tectis, compositis; omni soro stromate obscuro et e cellulis crasse tunicatis elongatisque constituto secernato; teleutosporis parum angulato-clavatis vel cylindraceis, 12-15  $\times$  30-48  $\mu$ , supra rotundatis vel obtusis, infra pedicellum versus plerumque contractis, non vel leniter constrictis; tunica castaneo-brunnea, 1.5-2  $\mu$  cr., apice ad 3-6  $\mu$  incrassata, levi; pedicello sporam dimidiam aequante vel brevior, hyalino vel tunicae sporum concolori.

*Mikania Argyreiae* DC. Rio de Janeiro, Brazil, Aug. 10, 1921, 1015 (type).

*Mikania buddleiaefolia* DC. Rio de Janeiro, Brazil, Aug. 9, 1921, 1003.

*Mikania* sp. City Park, Bello Horizonte, Minas Geraes, Brazil, Nov. 21, 1921, 1322.

This -opsis form is of the type of *Puccinia tenuis* (Schw.) Burrill. No pycnia could be found. It is entirely possible that this is the same as *Aecidium Mikaniae* P. Henn., originally described from near Blumenau, Santa Catharina, Brazil, on *Mikania confertissima*. Specimens of the type have, however, not been available.

373. *Puccinia mikanifolia* Jackson & Holway, sp. nov.

O. Pycnidiis non visis, verisimiliter carentibus.

III. Teleutosoris hypophyllis, crebre gregariis, in greges parvos 1-1.5 mm. diam. dispositis, maculis decoloratis insidentibus, parvis, rotundatis, 0.2-0.4 mm. diam., saepe confluentibus, mox nudis, castaneo-brunneis, ob germinationem parum cinerascentibus, compactis, pulvinatis, epidermide rupta non visibili; teleutosporis parum irregulariter clavatis vel cylindraceis,  $9-12 \times 28-45 \mu$ , supra rotundatis vel obtusis, plerumque infra contractis, septo leniter constrictis; tunica cinnamomeo-brunnea, tenui  $1 \mu$  minusve, apice conspicue crassata ad  $3.5-6.5 \mu$ , levi; pedicello hyalino, sporam aequante vel brevior.

*Mikania* sp. Pico, Itatiaya, Rio de Janeiro, Brazil, May 18, 1922, 1856.

This species appears to be quite distinct from *P. Spegazzinii*. The spores are shorter and narrower, and considerably more thickened at the apex. The sori are dark chestnut-brown.

374. *Puccinia Piqueriae* Jackson & Holway, sp. nov.

O. Pycnidiis non visis, verisimiliter carentibus.

III. Teleutosoris difformibus alteris germinativis hypophyllis sed quandoque epiphyllis, singulatim vel gregatim dispositis et in maculis subhypertrophicis decoloratis confluentibus, rotundatis, 0.4-1.0 mm. diam., mox nudis, primum cinnamomeo-brunneis, dein cinereis, compactis, pulvinatis, epidermider upta inconspicuis; alteris conquiscentibus hypophyllis singulatim dispositis vel quandoque confluentibus, 0.5-1.0 mm. diam., illis quandoque circumdantibus, obscure castaneo-brunneis, tarde nudis, compactis, pulvinatis; epidermide rupta cinctis; illorum teleutosporis clavatis vel cylindraceis,  $12-15 \times 30-45 \mu$ , supra rotundatis, infra truncatis et subangustatis, septo leniter vel non constrictis; tunica hyalina,

tenui,  $1\ \mu$  minusve, apice 3–5  $\mu$  incrassata, levi; pedicello brevi, forti, hyalino: horum teleutosporis clavatis, quandoque cylindraceis, supra rotundatis vel obtusis, pedicellum versus attenuatis, septo leniter vel non constrictis; tunica castaneo-brunnea, 1–1.5  $\mu$  cr., apice incrassata 4–9  $\mu$ , levi; pedicello sporam dimidiam aequante vel plerumque brevior, hyalino vel tunicae sporarum ritu tincto.

*Piqueria peruviana* (Gmel.) Rob. Huigra, Chimborazo, Ecuador, Aug. 2, 1920, 808 (type), 809; Hacienda del Urco, Urubamba Valley, Cuzco, Peru, July 4, 1920, 765.

In this micro-form the three collections form an interesting series. Collection 809 bears exclusively the lepto-form, while collection 765 bears only the dark sori of the micro-form. In collection 808, however, the dark sori of the resting form are commonly found surrounding the old sori of the germinating form. The description is drawn from all three collections, with No. 808 designated as the type.

375. PUCCINIA SPEGAZZINII DeToni, in Sacc. Syll. Fung. 7: 704. 1888.

*Puccinia australis* Speg. Anal. Soc. Ci. Argent. 10: 8. 1880 (Not Körn. 1876).

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*Mikania* sp. Huigra, Chimborazo, Ecuador, Aug. 3, 1920, 816; Campo Grande, Rio de Janeiro, Brazil, Sept. 19, 1921, 1128; Therezopolis, Rio de Janeiro, Brazil, Oct. 14, 1921, 1217; Jacarépaguá, Rio de Janeiro, Brazil, Nov. 16, 1921, 1313; Nictheroy, Rio de Janeiro, Brazil, Dec. 27, 1921, 1429; Ypiranga, São Paulo, Brazil, Feb. 23, 1922, 1592.

376. PUCCINIA TOLIMENSIS Mayor, Mém. Soc. Neuch. Sci. Nat. 5: 516. 1913.

*Eupatorium glutinosum* Lam. Quito, Ecuador, Aug. 19, 1920, 926.

*Stevia* sp. Sorata, Bolivia, Apr. 18, 1920, 542.

The collection of *Eupatorium glutinosum* is not typical of this rust species. The sori are blackish brown, not germinating, and the spore wall is dark chestnut-brown, greatly thickened at the

apex. The teliospores are somewhat broader and longer than is usual for the species, reaching  $70\ \mu$  in length. The collection might be made the basis of an undescribed species, but it seems best for the present to interpret it as a micro-condition of a species usually found in the lepto-phase. The species is known on *Eupatorium* from Colombia, Guatemala and from an isolated locality in New York.

While this species has not previously been reported on *Stevia*, there seems to be no reason why the collection listed above should not be assigned to it.

377. PUCCINIOSIRA EUPATORII Lagerh. Arth. Am. Jour. Bot. 5: 435. 1918.

*Eupatorium glechonophyllum* Less. Quito, Ecuador, Aug. 21, 1920, 935.

*Eupatorium* sp. Cuenca, Ecuador, Sept. 15, 1920, 988.

The two collections listed are recorded under this name since it would seem to be an open question whether this rust is the same as *Baeodromus Eupatorii* Arth., with which Arthur includes it in the N. Am. Flora (7: 700). The sori are larger and unaccompanied by pycnia. The structure is very difficult to determine, and the rust may not be a *Puccinosira*. The type of the species was made at Tichincha, Ecuador, by Lagerheim, in 1892.

#### SPECIES ON CARDUACEAE

##### (Tribe Astereae)

378. AECIDIUM ERIGERONTIS Kern & Whetzel, Jour. Dept. Agr. Porto Rico 14: 342. 1930.

*Erigeron bonariensis* L. Bello Horizonte, Minas Geraes, Brazil, Nov. 30, 1921, 1350.

*Erigeron* (Near *E. laxiflorus* Baker) Ouro Preto, Minas Geraes, Brazil, Dec. 8, 1921, 1371.

*Erigeron* sp. Huigra, Chimborazo, Ecuador, Aug. 3, 1920, 826.

These collections bear aecidia with aeciospores having the appearance of being thickened at the apex. The rust agrees well with the description, except that we find no spores as long as  $31\ \mu$ .



The rather prominent verrucose markings often appear to be deciduous, leaving smooth areas, particularly near the unthickened end.

379. *AECIDIUM SPEGAZZINII* DeToni, in Sacc. Syll. Fung. 7: 802. 1888.

*Aecidium australe* Speg. Anal. Soc. Ci. Argent. 17: 125. 1884  
(Not *A. australe* Berk. 1843).

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*Erigeron bonariensis* L. San Felipe, Sur Yungas, Bolivia,  
May 19, 1920, 618.

There would appear to be two species of *Aecidium* on *Erigeron bonariensis* in South America. This one has aeciospores with no appearance of thickening at one end and with the walls so finely verrucose as to appear smooth. The aecia are somewhat larger than in the collections referred to *A. Erigerontis*. We have not seen the type of *A. Spegazzinii*, but the collections seem best referred to that species for the present. It has been previously reported from Argentina, Brazil and Colombia. It seems quite possible that some of these reported collections may prove to be *A. Erigerontis*.

380. *PUCCINIA CONYZAE* P. Henn. Hedwigia 35: 239. 1896.

*Puccinia Baccharidis-triplinervis* P. Henn. Hedwigia 35: 241. 1896.

*Puccinia sordida* Dietel, Hedwigia 36: 31. 1897.

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*Conyza triplinervia* Less. Therezopolis, Rio de Janeiro, Brazil, Sept. 30, 1921, 1175; Ouro Preto, Minas Geraes, Brazil, Dec. 6, 1921, 1367; Barbacena, Minas Geraes, Brazil, Dec. 12, 1921, 1381; Novo Friburgo, Rio de Janeiro, Brazil, Jan. 3, 1922, 1451; Guarulhos, São Paulo, Brazil, Jan. 30, 1922, 1516; Campos do Jordão, São Paulo, Brazil, Apr. 20, 1922, 1736.

We have little hesitancy in assigning all these collections to the above species, which was originally described on the same host and from the same general region. The species is evidently common, but not known from other sections of South America. In our specimens the urediniospores may be 30  $\mu$  long, and the

teliospores are often narrower than given in the original description.

*Puccinia Baccharidis-triplinervis* P. Henn. is included as a synonym partly on the authority of Dietel (Ann. Myc. 12: 87. 1914). I have examined one of the two collections cited by Hennings (Ule 1449). The rust on this collection corresponds closely to that on the collections listed above.

381. *PUCCINIA DOLORIS* Speg. Anal. Soc. Ci. Argent. 12: 68. 1881.

*Erigeron hirtellus* DC. Papudo, Chile, Sept. 17, 1919, 36; Sept. 19, 1919, 49.

A distinct microcyclic species described originally from near Dolores, Argentina, and otherwise reported only from Colombia.

382. *Puccinia Heterothalami* Jackson & Holway, sp. nov.

O, I. Pycnidii et aecidiis praesentibus (*vide* infra).

II. Uredosoris amphigenis, sparsis, magnitudine variabilibus, 0.2-1.0 mm. diam., tarde nudis, subflavis, pulverulentis, epidermide irregulariter rumpente diu tectis; uredosporis ellipsoideis vel obovatis,  $18-22 \times 24-30 \mu$ ; tunica hyalina,  $1-1.5 \mu$ , crebre minuteque echinulato-verrucosa, poris obscuris praedita.

III. Teleutosoris uredosoris conformibus, plerumque 0.3-0.5 mm. diam., castaneo-brunneis, compactis, subpulvinatis; teleutosporis parum irregulariter ellipsoideis, oblongis vel obovatis,  $26-32 \times 38-45 \mu$ , supra rotundatis, infra rotundatis vel quandoque subangustatis, septo non vel lentissime constrictis; tunica aurato- vel pallide castaneo-brunnea, crassitudine variabili,  $1.5-3 \mu$ , apice late ad  $6-9 \mu$  et lateribus infra septum cellulae inferioris valde incrassata, levi; pedicello hyalino, flexuoso, sporam aequante vel brevior sed quandoque eam super.

*Heterothalamus boliviensis* Wedd. La Paz, Bolivia, Apr. 3, 1920, 493.

Old aecia accompanied by pycnia are present but too few to admit of accurate diagnosis. The aecia are caeomoid, large, 1 mm. in diameter, rupturing irregularly, spore mass whitish. The aeciospores are subglobose or ellipsoid,  $21-24$  by  $24-30 \mu$ , with thin, colorless walls  $1-1.5 \mu$ , finely and closely verrucose, the markings not arranged in lines.

While obviously of similar type to the rusts occurring on *Bac-*

*charis*, this species seems amply distinct, and occurs on a host genus on which no rust species have previously been reported.

#### ON THE GENUS *BACCHARIS*

Professor Holway obtained a most remarkable collection of *Baccharis* rusts in South America, consisting of over one hundred numbers. A great deal of time has been devoted to their study, and most of them are here reported. It became evident early in the work that a considerable number of apparently undescribed species were represented in the material. A great deal of difficulty has been encountered in separating them because of the inadequacy of many of the old descriptions. One of the most important characters in this group of rusts is the nature of the markings of the aeciospore wall, and these have often been poorly described. Fortunately, a considerable number of the type collections of species previously described has been available during the period in which this study has been made. The Arthur herbarium, at Purdue University, was consulted during June and July, 1931, and more recently the entire collection of *Baccharis* rusts in the Holway herbarium has been made available through the courtesy of Mrs. Mary M. Holway. Professor H. H. Whetzel, of Cornell University, has loaned me the types of Mayor's species, as well as the Colombian collections made by Chardon and Toro.

Twenty-six species of *Puccinia* occurring on *Baccharis* have previously been reported. Most of these appear to be distinct. In the Holway collections from South America we have encountered eighteen that seem to be different. These are described in the following pages. It has seemed desirable to furnish a key in order to indicate the basis on which the species described as new have been separated. Since comparative characters and spore size have of necessity been used frequently in the key, a number of species will be found in more than one place.

One of the interesting results of this study is that a series of seven species has been brought to light, which have deep seated, epiphyllous aecia, without peridia and with the aeciospore walls definitely and often strongly echinulate. Only one of these species, *P. Baccharidis-rhexioides* Mayor, has been previously recognized.

It should, perhaps, be explained why the genus *Eriosporangium* has not been used. It has seemed to the writer that this genus is not a natural one, and that it is impracticable to attempt to separate it from *Puccinia*. It is true that the greater number of the species occurring on *Baccharis* have caeomoid aecia. If, however, a range of hosts in the Carduaceae is considered, every gradation can be found, from the caeomoid type of aecium, as found in the rusts on *Baccharis*, to the acidoid aecium of the typical *Puccinia*. As to the teliospores, many species having typical acidoid aecia are known to have teliospores with thin, light colored walls, which germinate at once. There are species known which occur on *Vernonia* and *Ilyptis* in which two sorts of teliospores occur, thin, light colored spores germinating at once, and dark, thick walled resting spores. We do not feel that anything is to be gained by attempting a separation of a genus on these bases.

## KEY TO SPECIES OF PUCCINIA ON BACCHARIS

- Teliospore wall thick, conspicuously roughened..... 395. *P. impolita*.
- Teliospore wall usually thin, smooth or rarely punctate.
- Teliospore wall not conspicuously thickened above, thin, light colored.  
(Species with apices slightly thickened 2.5–4  $\mu$  are included here.)
- Teliospores averaging less than 50  $\mu$  long.
- Teliospores more than 25  $\mu$  wide.. *P. praeandina* Speg.
- Teliospores less than 25  $\mu$  wide.
- All spore forms present; cucurbitate.
- Aeciospore wall finely echinulate..... *P. Baccharidis-rhexioides*.
- Aeciospore wall verrucose or rugose.
- Aeciospore wall rugose or verrucose rugose in lines.
- Urediniospores 20–24 by 24–30  $\mu$ ..... *P. exornata*.
- Urediniospores 18–20 by 21–26  $\mu$ ..... 396. *P. improcera*.
- Aeciospore wall verrucose, not in lines..... *P. oaxacana*.

- Only teliospores known; micro-form..... 401. *P. perspicabilis*.
- Teliospores averaging over 50  $\mu$  long.  
 Teliospore wall colorless.  
 Teliospores averaging less than 65  $\mu$  long.  
 Uredinia unknown, aeciospore wall verrucose in striae..... 394. *P. Henningsii*.  
 Uredinia present, aeciospore wall verrucose, not in striae..... *P. Mayerhansii*  
 Teliospores averaging over 65  $\mu$  long..... 404. *P. praedicabilis*.  
 Teliospore wall distinctly colored.  
 Uredinia unknown.  
 Aecia present; ?-opsis forms.  
 Aeciospore wall finely verrucose in lines.  
 Aeciospores 21–26 by 26–30  $\mu$ ..... *P. Montoyae*.  
 Aeciospores ellipsoid, 30–40  $\mu$  long.  
 Teliospores not or very slightly constricted, pedicel short... *P. Baccharidis-cassinoides*.  
 Teliospores strongly constricted, pedicel long... 399. *P. inopina*.  
 Aeciospore wall strongly echinulate, 28–32 by 32–45  $\mu$ ..... 383. *P. albula*.  
 Aecia unknown; micro-form. 401. *P. perspicabilis*.  
 Uredinia present.  
 Urediniospore wall echinulate.  
 Urediniospore wall moderately and strongly echinulate..... *P. baccharidicola*.  
 Urediniospore wall sparsely and finely echinulate; aeciospore wall echinulate..... 384. *P. alia*.  
 Urediniospore wall verrucose or verrucose rugose.  
 Urediniospores (?) 19–22 by 22–28  $\mu$ ..... *P. Baccharidis-cassinoides*.

- Urediniospores 22-27 by  
32-48  $\mu$  . . . . . 402. *P. pervenusta*.
- Teliospore wall appreciably thickened  
above, 5  $\mu$  or more (a few species  
thickened 3-4  $\mu$  are repeated here).  
Teliospores averaging less than 45  $\mu$   
long.  
Teliospores averaging more than  
25  $\mu$  wide.  
Urediniospores unknown, aecio-  
spores coarsely rugose . . . . . 403. *P. praeculta*.  
Urediniospores present, aecio-  
spores when present not  
as above.  
Urediniospores finely and  
closely echinulate.  
Teliospore wall smooth.  
Teliospores 27-32 by  
35-45  $\mu$  . . . . . *P. sphenica*.  
Teliospores 24-34 by  
42-48  $\mu$  . . . . . 408. *P. unicolor*.  
Teliospore wall minutely  
punctate . . . . . *P. egressa*.  
Urediniospore wall strongly  
and sparsely echinulate,  
teliospore wall minutely  
punctate . . . . . *P. Baccharidis-histellae*.  
Teliospores averaging less than  
25  $\mu$  wide.  
Urediniospores unknown, aeci-  
ospore wall coarsely ridged . . . . . 403. *P. praeculta*.  
Urediniospores present, aecio-  
spores when present not  
as above.  
Teliospores less than 18  $\mu$   
broad.  
Apex of teliospore thick-  
ened, 6-12  $\mu$  . . . . . *P. pistoriga*.  
Apex of teliospore slight-  
ly thickened, 3-4  $\mu$  . . . . . 396. *P. improcera*.  
Teliospores more than 18  $\mu$   
broad.  
Teliospore wall minutely  
punctate . . . . . *P. egressa*.  
Teliospore wall smooth.  
Pedicel long, persist-  
ent. Apex thick-  
ened 2-4  $\mu$  . . . . . *P. exonerata*.  
Pedicel usually short.

- Apex thickened  
3-4  $\mu$  . . . . . 396. *P. improcera*.
- Apex thickened  
4-7  $\mu$ .  
Urediniospores  
23-28 by  
30-40  $\mu$  . . . . . *P. Montserrates*.
- Urediniospores  
22-24 by  
26-33  $\mu$  . . . . . 405. *P. praedicta*.
- Teliospores between 45 and 60  $\mu$  long.  
Teliospores averaging more than  
26  $\mu$  broad.  
Aeciospore wall coarsely and  
prominently tuberculate . . . . . 386. *P. Baccharidis-sparteae*.
- Aeciospore wall finely verru-  
cose.  
Aeciospore wall markings  
not in lines . . . . . 392. *P. evadens*.
- Aeciospore wall markings in  
lines . . . . . 385. *P. Baccharidis*.
- Teliospores averaging less than 26  $\mu$   
broad.  
Teliospores thickened 6  $\mu$  or less  
at apex.  
Aeciospore wall echinulate . . . . . 398. *P. indagata*.
- Aeciospore wall densely and  
coarsely verrucose . . . . . *P. Montoyae*.
- Teliospores thickened 6  $\mu$  or  
more at apex.  
Pedicel long, persistent . . . . . *P. Baccharidis-cylindrica*.
- Pedicel usually no longer  
than spore.  
Urediniospores absent or  
unknown.  
Micro-form, telio-  
spore apex 6-12  $\mu$ . . . . . 397. *P. incomposita*.
- Opsis forms, telio-  
spore apex 5-  
9  $\mu$ .  
Aeciospore wall  
finely verru-  
cose-rugose . . . . . 390. *P. consulta*.
- Aeciospore wall  
coarsely ridged. . . . . 403. *P. praeculta*.
- Urediniospores present.  
Urediniospores  
strongly thickened  
at apex . . . . . *P. Baccharidis-multiflorae*.

- Urediniospores  
not appreciably  
thickened at  
apex.
- Urediniospore  
pores evident,  
8 scattered.... 385. *P. Baccharidis*.
- Urediniospore  
pores ob-  
scure.
- Urediniospores  
narrow, 16-  
20  $\mu$  wide... 406. *P. ruderaria*.
- Urediniospores  
more than  
20  $\mu$  wide.
- Uredinio-  
spores  
22-25 by  
24-27  $\mu$ . 389. *P. consueta*.
- Uredinio-  
spores  
23-26 by  
30-40  $\mu$ . 407. *P. salebrata*.
- Teliospores averaging more than 60  $\mu$   
long.
- Urediniospores absent or unknown;  
(?) -opsis and micro-forms.
- Teliospores averaging over 75  $\mu$   
long; micro-form . . . . . 387. *P. caeomatiformis*.
- Teliospores averaging less than  
75  $\mu$  long; (?) -opsis forms.
- Aeciospore wall echinulate.
- Markings finely echinu-  
late, moderately  
spaced . . . . . 399a. *P. interjecta*.
- Markings strongly and  
sparsely echinulate... 393. *P. expetiva*.
- Aeciospore wall not echinu-  
late.
- Side walls of teliospores  
2-3  $\mu$  thick . . . . . 400. *P. perincerta*.
- Side walls of teliospores  
less than 1.5  $\mu$   
thick.
- Teliospore apex 3-4  $\mu$ ,  
aeciospore wall  
markings in rows.. 399. *P. inopina*.
- Teliospore apex thick-



ened 4-7  $\mu$ , aecio-  
spore wall mark-  
ings not in rows,  
prominently verru-  
cose tuberculate. .

*P. Ancizari.*

Urediniospores present.

Wall of urediniospore brown,  
echinulate.

Urediniospore wall pores 4,  
equatorial. . . . . 388. *P. chilensis.*

Urediniospore wall pores 6,  
in three bands. . . . . 391. *P. cuzcoensis.*

Wall of urediniospore colorless,  
verrucose-rugose. . . . . 402. *P. pervenusta.*

### 383. *Puccinia albula* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, numerosis, sparsius gregariis, maculis flavidis gregatim insidentibus, aecidiis circumclusis, parvis, punctiformibus, flavidis, subglobois vel subconicis, 120-135  $\times$  135-150  $\mu$ ; periphysibus columnam brevem efformantibus.

I. Aecidiis epiphyllis, circum pycnidia dispositis, profunde insidentibus, tarde nudis, poro irregulari apertis, soro flavescenti praeditis; aecidiosporis ellipsoideis vel subglobois, 28-32  $\times$  32-45  $\mu$ ; tunica hyalina, 2.5-3.5  $\mu$  cr., crasse sparseque echinulata, acuminibus 3-6  $\mu$  inter se secernatis et 2-3  $\mu$  longis praedita.

III. Teleutosoris hypophyllis, sparsis vel gregariis, in maculis flavescentibus sitis, parvis, rotundatis, 0.2-0.3 mm. diam., mox nudis, compactis, dein pulvinatis, splendide aurato-brunneis, germinando cinerascens; epidermide fissa non visibili; teleutosporis ellipsoideis, oblongis vel subclavatis, 20-24  $\times$  48-68  $\mu$ , supra rotundatis, infra pedicellum versus rotundatis vel quandoque angustatis, ut plurimum septo valde constrictis; tunica flavescenti, tenui 1-1.5  $\mu$ , apice leniter vel non ad 2.5  $\mu$  incrassata, levi; pedicello hyalino, fragili, sporam aequante vel brevior.

*Baccharis* sp. Nictheroy, Rio de Janeiro, Brazil, Sept. 23, 1921, 1149.

This species is separable from others having aeciospores with echinulate wall markings, by the narrow teliospores, thickened only slightly at the apex, and the large, thick walled, very sparsely echinulate aeciospores.

Aecia unaccompanied by pycnia, for the most part epiphyllous, occasionally hypophyllous, are abundant in this material. They seem to be of the same structure as those with pycnia and the spores are the same. Telia are often found on the under side of the spots where these occur.

384. *Puccinia alia* Jackson & Holway, sp. nov.

O, I. Pycnidiis et aecidiis praesentibus, vetustis (*vide infra*).

II. Uredosoris hypophyllis, sparsis vel gregariis, quandoque circinatim dispositis, rotundatis vel irregulariter formatis, 0.3–0.8 mm. diam., tarde nudis, albidis vel flavescentibus, pulverulentis, epidermide fissa cinctis; uredosporis obovatis,  $18-24 \times 24-30 \mu$ ; tunica hyalina vel subflavida,  $1.5-2 \mu$  cr., minute sparseque echinulata, poris obscuris praedita.

III. Teleutosoris hypophyllis, sparsis vel gregariis, rotundatis, 0.3–0.6 mm. diam., nitide castaneo-brunneis, deinde germinatione cinereis, mox nudis, compactis, primum applanatis, dein pulvinatis; epidermide rupta utplurimum non visibili; teleutosporis oblongo-cylindraceis vel subclavatis,  $16-21 \times 45-65 \mu$ , supra rotundatis vel obtusis, infra pedicellum versus rotundatis vel angustatis, septo valde constrictis; tunica aurato-brunnea, tenui,  $1-1.5 \mu$ , apice leniter incrassata ad  $2.5-3.5 \mu$ , levi; pedicello hyalino, flexuoso, sporam aequante vel brevior.

*Baccharis trinervis* (Lam.) Pers. Rio de Janeiro, Brazil, Aug. 9, 1921, 1007 (type); Rio de Janeiro, Brazil, Aug. 25, 1921, 1072; Nictheroy, Rio de Janeiro, Brazil, Sept. 23, 1921, 1151.

This species forms one of a series of seven species having deep seated, epiphyllous aecia, without peridia, opening by a pore, and having aeciospores with definitely echinulate wall markings. These aecia, in all cases which we have examined, arise from below the palisade layer of leaf tissue.

The aecia in this species are too old to permit an adequate diagnosis. They are epiphyllous, deep seated, opening by a pore. The aeciospores are ellipsoid or subglobose,  $18-21$  by  $22-26 \mu$ , with colorless walls  $1.5-2 \mu$  thick, finely and sparsely echinulate. Epiphyllous pycnia accompany the aecia.

With the exception of *P. Baccharidis-rhexioides* Mayor, this is the only species we have encountered in this group having urediniospores. Our species is separable from that species by the small size of the aeciospores.

385. *PUCCINIA BACCHARIDIS* Dietel & Holway; Dietel, *Erythea* 1: 250. 1893.

*Baccharis Burchellii* Baker ? Varzea, Therezopolis, Rio de Janeiro, Brazil, Sept. 30, 1921, 1174.

*Baccharis Feuillei* DC. Choisica, Peru, July 22, 1920, 777.

*Baccharis floribunda* H.B.K. Huigra, Chimborazo, Ecuador, Aug. 4, 1920, 836.

*Baccharis glutinosa* Pers. Cuzco, Peru, July 1, 1920, 750.

*Baccharis marginalis* DC. Papudo, Chile, Sept. 16, 1919, 26.

*Baccharis* (Near *B. oxydonta* DC.) Therezopolis, Brazil, Sept. 29, 1921, 1172; Petropolis, Brazil, Oct. 30, 1921, 1259.

*Baccharis* sp. Riobamba, Ecuador, Aug. 10, 1920, 860; Quito, Ecuador, Aug. 13, 1920, 878, Aug. 23, 1920, 942; Therezopolis, Rio de Janeiro, Brazil, Sept. 28, 1921, 1164.

Collections with rather wide teliospores measuring between 45 and 65  $\mu$  long, and with walls only slightly thickened at the apex are included here, together with collections of uredinia with colored walls and scattered pores. Aeciospores, where present, have punctate-striate markings.

Whether or not any collections from South America are properly to be referred to this species is an open question.

386. ***Puccinia Bacchæridis-spartea*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, laxius gregariis, in maculis magnis flavidisque confertis, prominentibus, punctiformibus, flavidis vel auriantiacis, globosis vel depresso globosis, 150–180  $\mu$  altis, 200–220  $\mu$  latis; periphysibus non extrusis.

I. Aecidiis hypophyllis, caematiformibus, paucis, in maculis flavescentibus contra pycnidia dispositis, magnis, 0.5–1.2 mm. diam., tarde nudis, pulverulentis, subflavis, epidermide inflata irregulariterque rumpente diu tectis; aecidiosporis late ellipsoideis vel subglobosis, 24–30  $\times$  30–38  $\mu$ ; tunica hyalina, 2–2.5  $\mu$  cr., finibus quandoque leniter incrassata ad 3–3.5  $\mu$ , crasse et prominenter tuberculata, verrucis inter se longe remotis sed quandoque confluentibus itaque costas elongatas efformantibus praedita.

II. Uredosoris amphigenis, sparsis, parvis, 0.3–0.4 mm. diam., tarde nudis, albidis, pulverulentis, epidermide diu tectis; uredosporis ellipsoideis, 24–26  $\times$  30–35  $\mu$ ; tunica hyalina, 2–2.5  $\mu$  cr., minute crebreque echinulata, poris obscuris praedita.

III. Teleutosoris plerumque hypophyllis, sparsis, rotundatis, 0.2–0.5 mm. diam., mox nudis, castaneo-brunneis, germinando cinereis, primum appanatis, dein pulvinatis; epidermide rupta aegre visibili; teleutosporis ellipsoideis, oblongis vel clavatis, 24–30  $\times$  45–62  $\mu$ , supra rotundatis, infra plerumque rotundatis sed quandoque ad pedicellum contractis, non vel leniter septo con-

strictis; tunicae cinnamomeo- pallide castaneo-brunnea, 1–1.5  $\mu$  cr., apice ad 6–8  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel brevior.

*Baccharis spartea* Benth. San Felipe, Sur Yungas, Bolivia, May 21, 1920, 633.

A species separable from others on this host genus by the strongly tuberculate aeciospore wall with markings sparsely placed, and by the large, broad teliospores, thickened at the apex. The teliospores are somewhat like those of *P. chilensis* Diet. & Neg., but the urediniospores are very different.

387. PUCCINIA CAEOMATIFORMIS Lagerh. in Sydow, Monog. Uredin. 1: 24. 1902.

? *Puccinia colossea* Speg. Rev. Argent. de Bot. 1: 111. 1925.

*Baccharis floribunda* H.B.K. San Felipe, Sur Yungas, Bolivia, May 19, 1920, 613; Coroico, Nor Yungas, Bolivia, June 11, 1920, 728; Riobamba, Ecuador, Aug. 10, 1920, 859; Quito, Ecuador, Aug. 13, 1920, 874; Cuenca, Azuay, Ecuador, Sept. 10, 1920, 972.

*Baccharis subpenninervis* Sch. Bip. Sorata, Bolivia, Apr. 12, 1920, 512; San Felipe, Sur Yungas, Bolivia, May 19, 1920, 615.

*Baccharis* sp. (aff. *B. glutinosa* Pers.) Huigra, Chimborazo, Ecuador, Aug. 3, 1920, 814.

*Baccharis* sp. El Chaco, Sur Yungas, Bolivia, May 25, 1920, 644; Urubamba, Cuzco, Peru, July 3, 1920, 757; Huigra, Chimborazo, Ecuador, Aug. 4, 1920, 843; Foot of Cotopaxi, Ecuador, Aug. 12, 1920, 873; Portovelo, Prov. del Oro, Ecuador, Sept. 22, 1920, 998.

While this species seems to have been reported previously only from Ecuador and Colombia, it would appear to be quite common in the Andes region.

*Puccinia colossea* Speg. is cited as a possible synonym. The type has not been available.

388. PUCCINIA CHILENSIS Dietel & Neger, in Engl. Bot. Jahrb. 22: 354. 1896.

*Baccharis racemosa* (Mol.) DC. Zapallar, Chile, Feb. 1, 1920, 312.

This collection is typical for the species, the characters of which are very distinct. The species is somewhat like *P. Baccharidis* Dietel & Holway, but the teliospores are much broader and the urediniospores have four equatorial pores. The teliospore pedicel may be inflated as in *P. Baccharidis*.

389. ***Puccinia consueta*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, prominentibus, crebre gregariis, maculis flavidis profunde insidentibus, globosis vel ellipsoideis, 150–200  $\mu$  latis, 190–210  $\mu$  altis.

I. Aecidiis amphigenis sed ut plurimum hypophyllis, cum nervis foliorum saepe immixtis, magnis, 0.5–0.8 mm. diam., caemati-formibus, tarde nudis, soro flavescenti praeditis, pulverulentis, epidermide irregulariter erumpente diu tectis; aecidiosporis ellipsoideis, 21–24  $\times$  30–34  $\mu$ ; tunica hyalina vel flavescenti, 1.5–2  $\mu$ , crebre minuteque verrucosa, striata.

II. Uredosoris hypophyllis, sparsis, rotundatis, parvis, 0.2–0.4 mm. diam., flavidis, mox nudis, pulverulentis, epidermide plerumque visibiliter cinctis; uredosporis subglobosis vel late obovatis, 22–25  $\times$  24–27  $\mu$ , tunica flavescenti tenui 1–1.5  $\mu$  minute crebreque verrucosa praeditis; poris parum obscuris sed adparenter 3, aequatorialibus.

III. Teleutosoris hypophyllis, sparsis, parvis, rotundatis, 0.3–0.5 mm. diam., mox nudis, obscure cinnamomeo-brunneis, dein germinando cinereis, pulvinatis; epidermide rupta non visibili; teleutosporis ellipsoideis, oblongis vel clavatis, 18–24  $\times$  45–60  $\mu$ , apice rotundatis, infra pedicellum versus rotundatis vel contractis, septo leniter vel non constrictis; tunica aurato-brunnea, 1.5–2  $\mu$  cr., angulis superioribus loculi inferioris valde et apice usque 6–8  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel brevior, non inflato.

*Baccharis* (Near *B. saliens* Rusby), Quito, Ecuador, Aug. 23, 1920, 940.

Separable because of urediniospore characters and the narrow teliospores, greatly thickened at the apex.

390. ***Puccinia consulta*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, numerosis, in maculis subflavis laxe gregatim dispositis, punctiformibus, primum aurantiaceis, dein brunneolis, profunde insidentibus, ellipsoideis, parvis, 75–90  $\mu$  latis, 90–120  $\mu$  altis; periphysibus fasciculum 30–45  $\mu$  altum efformantibus.

I. *Aecidiis hypophyllis*, plerumque singulatim sed quandoque in greges 2-4 dispositis, magnis, caematiformibus, rotundatis vel irregularibus, 0.5-1.0 mm. diam., peridio carentibus, epidermide inflata irregulariterque erumpente diu tectis; aecidiosporis subglobosis vel saepius late ellipsoideis,  $20-26 \times 30-40 \mu$ , quandoque longioribus et tunc una vel utraque fine subacutis; tunica incolori, tenui,  $1-1.5 \mu$ , minutius sed conspicue verrucoso-rugosa, verrucis saepe confluentibus sed non striatis praedita.

III. *Teleutosoris hypophyllis*, sparsis vel ut plurimum gregariis, saepe inter aecidia confertis, parvis, rotundatis, 0.2-0.5 mm. diam., pallide castaneo-brunneis, germinando cinerascentibus, compactis, pulvinatis, epidermide rupta non conspicuis; teleutosporis clavatis, ellipsoideis vel oblongis,  $18-24 \times 45-60 \mu$ , supra rotundatis, infra rotundatis vel saepius contractis, non vel lentissime septo constrictis, tunica pallide cinnamomeo- vel aurato-brunneola  $1 \mu$  cr. apice ad  $5-8 \mu$  crassiore levi praeditis; pedicello hyalino, sporam aequante vel duplo longiore, ut plurimum brevior.

*Baccharis orgyalis* DC. Itatiaya, Rio de Janeiro, Brazil, May 19, 1922, 1870; Therezopolis, Rio de Janeiro, Brazil, Sept. 28, 1921, 1161; Varzea, Therezopolis, Rio de Janeiro, Brazil, Sept. 30, 1921, 1176 (type).

*Baccharis pauciflosculosa* DC. Bosque da Saude, São Paulo, Brazil, Feb. 1, 1922, 1525.

*Baccharis Schultzii* Baker, Ouro Preto, Minas Geraes, Brazil, Dec. 9, 1921, 1377; Bosque da Saude, São Paulo, Brazil, Feb. 1, 1922, 1524; Campos do Jordão, São Paulo, Brazil, Apr. 24, 1922, 1768.

*Baccharis* sp. Petropolis, Rio de Janeiro, Brazil, Oct. 29, 1921, 1253, Nov. 1, 1921, 1266; Novo Friburgo, Rio de Janeiro, Brazil, Jan. 2, 1922, 1444; Itatiaya, Rio de Janeiro, Brazil, May 18, 1922, 1859.

These collections were at first referred to *P. Montoyae* Mayor on the basis of description. A comparison with the type material, however, shows that species to be quite different. In *P. Montoyae* the teliospores are usually strongly constricted, and only very slightly thickened at the apex, about  $4 \mu$ . Often the thickening is merely at the sides of the apical germ pore. The aeciospores also are smaller, with the wall markings finely verrucose and arranged in longitudinal rows.

The description is drawn largely from specimen No. 1176 on *Baccharis orgyalis* DC. The other collections, in general, show remarkably close correspondence in teliospore characters and in aecial characters where present. No uredinia or urediniospores could be found in any of the collections. The collection on *B. paucifloculosa* has aeciospores somewhat smaller and with rather finer wall markings, more closely set, with less tendency to be rugose.

391. PUCCINIA CUZCOENSIS Arth. Bot. Gaz. 65: 471. 1918.

*Baccharis floribunda* H.B.K. Hacienda del Urco, Urubamba Valley, Cuzco, Peru, July 4, 1920, 764.

*Baccharis Fevillei* DC.? Arequipa, Peru, July 10, 1920, 769.

The type collection of this species was made in the same region as the first specimen listed above, and on the same host. Only aecia and uredinia were known when the species was described. The urediniospores are very characteristic. The original description states that the pores are two and equatorial. There are six pores, two equatorial, two near the apex and two near the base. The two at the equator are on an axis which is at right angles to that between each of the two pairs near the extremities. When the two equatorial pores are in optical section, the spores appear rhomboidal in outline, and the pores at either end are in face view; when the equatorial pores are in face view, the spore is ellipsoid or oblong and the two sets of pores at the ends appear in optical section.

Both collections bear telia. These are scattered, pulvinate, dark brown, becoming cinereous by germination. Teliospores clavate or cylindrical 24–30 by 72–90  $\mu$ , rounded or obtuse above, usually narrowed below, constricted at the septum. The wall is cinnamon brown, firm but thin, 1–1.5  $\mu$ , thickened 5–8  $\mu$  at the apex. The pedicels are long, 1–1.5 times the length of the spore and often inflated. The telia and teliospores somewhat resemble those of *P. caeomatiformis* Lag. In connection with the original description, Arthur comments on the resemblance of the aecia to *P. Montoyae* Mayor, which occurs on the same host in Colombia. The species is, however, very different from *P. Montoyae*, especially in teliospore characters.

392. *PUCCINIA EVADENS* Hark. Bull. Calif. Acad. 1: 34. 1884.

*Baccharis floribunda* H.B.K.? La Paz, Bolivia, March 20, 1920, 439.

*Baccharis platypoda* DC. Ouro Preto, Minas Geraes, Brazil, Dec. 7, 1921, 1369.

*Baccharis* sp. La Paz, Bolivia, March 20, 1920, 437; Bello Horizonte, Minas Geraes, Brazil, Nov. 23, 1921, 1329; Campos do Jordão, São Paulo, Brazil, Apr. 20, 1922, 1741, Itatiaya, Rio de Janeiro, Brazil, May 18, 1922, 1860.

Collections have been tentatively referred to *P. evadens* Hark., which have large, broad teliospores which are considerably thickened at the apex, and which have broad, usually colorless urediniospores with rather sparse wall markings.

The forms on *Baccharis* having large, broad teliospores, thickened at the apex, are difficult to assign with any degree of satisfaction. It would seem to the writer that there are several species in South America usually referred either to *P. evadens* or *P. Baccharidis*. Just what the specific limits are, is difficult to determine from the usually meagre material available.

393. *Puccinia expetiva* Jackson & Holway, sp. nov.

O. Pycnidiis amphigenis, paucis, maculis decoloratis subhypertrophicis insitis, punctiformibus, subglobosis vel obovatis, 150–180  $\mu$  altis, 165–180  $\mu$  latis; periphysibus non prominentibus.

I. Aecidiis epiphyllis, gregariis, circum gregem pycnidiorum in maculis decoloratis saepe subforte hypertrophicis dispositis, magnis, profunde insidentibus, matricibus inflatis dui velatis sed tandem poro irregulari apertis, soro flavido instructis; aecidiosporis subglobosis vel ellipsoideis, 22–28  $\times$  30–38  $\mu$ ; pariete incolori, crasso, 2.5–3  $\mu$ , utraque fine ad 4–6  $\mu$  quandoque incrassata, sparsissime et valde echinulata, poris obscuris praedita.

III. Teleutosoris hypophyllis, sparsis, plerumque in maculis subflavis dispositis, rotundatis, 0.4–0.8 mm. diam., mox nudis, splendide castaneo-brunneis, ob germinationem cinereis, compactis, primum applanatis, dein pulvinatis, epidermide rupta in soris junioribus solis cinctis; teleutosporis ellipsoideis, oblongis vel subclavatis, 26–32  $\times$  65–90  $\mu$ , supra rotundatis, infra pedicellum versus rotundatis vel contractis, septo leniter vel non contractis; tunica nitide aurato- vel pallide castaneo-brunnea, 1–2  $\mu$  cr., apice usque ad 6–9  $\mu$  incrassata, levi; pedicello hyalino, sporam longitudine aequante, in umbilico lato, quandoque leniter inflato, dein flexuoso.



*Baccharis* sp. Huigra, Chimborazo, Ecuador, Aug. 4, 1920, 831.

Distinguished from other species having aeciospores with echinulate wall markings by the long teliospores greatly thickened at the apex and by the thickness of the aeciospore wall and the strong, sparsely placed wall markings.

The pycnia and aecia in this collection are old, admitting of only incomplete description.

394. *PUCCINIA HENNINGSII* Dietel, *Hedwigia* 36: 31. 1897.

*Caeoma Negerianum* Dietel, in *Engl. Bot. Jahrb.* 22: 357. 1896.

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*Baccharis dracunculifolia* DC. Sabará, Minas Geraes, Brazil, Dec. 2, 1921, 1359; Bosque da Saude, São Paulo, Brazil, Jan. 31, 1922, 1523; Poá, São Paulo, Brazil, Apr. 14, 1922, 1732.

*Baccharis* sp. Therezopolis, Rio de Janeiro, Brazil, Sept. 28, 1921, 1153, Sept. 29, 1921, 1171, Oct. 6, 1921, 1195; Petropolis, Rio de Janeiro, Brazil, Oct. 21, 1921, 1241; Novo Friburgo, Rio de Janeiro, Brazil, Jan. 2, 1922, 1440, Jan. 5, 1922, 1457; Bosque da Saude, São Paulo, Brazil, Jan. 31, 1922, 1517.

The type collection of this species was made at Blumenau, Brazil, by E. Ule (No. 910) on the host first listed above. The species seems to be a distinct one. Aecia are present in some of the collections listed above. No urediniospores were found. Collections have been included which have aeciospores finely verrucose with markings arranged in lines sometimes forming striae, but more commonly forming an irregular net work, and with teliospores having colorless walls, not over 60  $\mu$  long and essentially unthickened at the apex. There is some variation, and it may be that there is more than one species in this group.

*Caeoma Negerianum* is included as a synonym on the authority of Dietel (*Ann. Myc.* 12: 87. 1914). Arthur includes this *Caeoma* under *Puccinia evadens*.

395. *Puccinia impolita* Jackson & Holway, sp. nov.

II. *Uredosoris amphigenis*, sparsis, parvis, rotundatis, 0.2-0.4 mm. diam., cinnamomeo-brunneis, tarde nudis, pulverulentis,

epidermide inflata diu tectis; uredosporis late ellipsoideis vel obovatis,  $23-25 \times 27-32 \mu$ ; tunica cinnamomeo- vel aurato-brunnea,  $1.5-2 \mu$  cr., sparsius minuteque echinulata; poris obscuris, 3, fere aequatorialibus.

III. Teleutosoris amphigenis, sparsis, rotundatis, 0.2–0.4 mm. diam., nigricantibus, tarde nudis, dein pulverulentis, epidermide rupta cinctis; teleutosporis late ellipsoideis,  $26-32 \times 38-48 \mu$ , utrinque rotundatis, medio non constrictis; tunica obscure castaneo-brunnea,  $4-5 \mu$  cr., apice et supra porum cellulae inferioris septo ad  $9 \mu$  incrassata, sparse rugoso-reticulata, plicis humilibus interruptisque instructa; pedicello hyalino, sporam aequante vel duplo longiore, firmo,  $6-9 \mu$  diam., saepe infra angustato.

*Baccharis scandens* Pers. Sorata, Bolivia, Apr. 19, 1920, 546.

The only *Baccharis* rust which we have encountered having thick, prominently marked teliospore walls.

396. ***Puccinia improcera*** Jackson & Holway, sp. nov.

O. Pycnidii epiphyllis, paucis, in maculis flavescentibus vel decoloratis crebre aggregatis, punctiformibus, globosis vel ellipsoideis,  $95-110 \mu$  altis,  $90-100 \mu$  latis; periphysibus fasciculum densum  $30-45 \mu$  altum efformantibus.

I. Aecidiis hypophyllis, singulatim vel in greges 2–4 contra pycnidia dispositis, minusculis, 0.5–0.8 mm. diam., profunde insidentibus, caeomatiformibus, tarde nudis, soro albido instructis, pulverulentis, epidermide inflata diu tectis; aecidiosporis ellipsoideis,  $18-24 \times 22-30 \mu$ , tunica  $2-2.5 \mu$  moderate prominenter rugosa praeditis.

II. Uredosoris aliis hypophyllis aliisque cauliculis, sparsis, rotundatis, 0.2–0.4 mm. diam., his majoribus et elongatis, utrisque pallide cinnamomeo-brunneis, mox nudis, pulverulentis, epidermide rupta plerumque visibiliter cinctis; uredosporis ellipsoideis vel obovatis,  $18-20 \times 21-26 \mu$ ; tunica pallide cinnamomeo-brunnea,  $1-1.5 \mu$  cr., sparse ac tenuiter echinulata, area levi circum poros praedita; poris 2, aequatorialibus.

III. Teleutosoris hypophyllis, sparsis, rotundatis, parvis, 0.2–0.4 mm. diam., obscure cinnamomeo- vel pallide castaneo-brunneis, dein e germinatione cinereis, mox nudis, pulvinatis; epidermide rupta non visibili; teleutosporis ellipsoideis, oblongis vel clavatis,  $15-20 \times 30-46 \mu$ , supra rotundatis vel obtusis, infra ad pedicellum rotundatis vel contractis, septo plerumque visibiliter constrictis, tunica tenui  $1-1.5 \mu$  apice ad  $3-4 \mu$  leniter incrassata levi praeditis; pedicello hyalino, sporam aequante vel brevior.

*Baccharis anomala* DC. Campos do Jordão, São Paulo, Brazil, Apr. 20, 1922, 1740 (type); Curityba, Paraná, Brazil,

June 20, 1922, 1977; Mogy das Cruzes, São Paulo, Brazil,  
July 4, 1922, 2003.

This well marked species may be distinguished by the small, narrow teliospores and the small aeciospores with rugose wall markings. It appears to be most closely related to *P. exornata* Arth., from which it differs in having narrower teliospores and smaller urediniospores.

*Uredo Baccharidis-anomala* Mayor, described from Colombia on the same host, has been compared, and, until aecia and telia are collected in the same region, it seems best to regard it as a distinct species. The urediniospores, while about the same size as our species, have much thicker walls, with the echinulate markings more closely placed and somewhat more prominent.

397. ***Puccinia incomposita*** Jackson & Holway, sp. nov.

O. Pycnidiis non visis, probaliter carentibus.

III. Teleutosoris hypophyllis, in greges 1.5–2.5 mm. diam. collectis, maculis flavescentibus insidentibus, parvis, rotundatis, 0.2–0.3 mm. diam., inter se longe secernatis, saepe concentricis dispositis, primum pallide castaneo-brunneis, deinde germinando parum cinerascentibus, tardius nudis, compactis, applanatis; epidermide rupta visibili; teleutosporis ellipsoideis vel late clavatis,  $18\text{--}24 \times 45\text{--}60 \mu$ , supra rotundatis, infra pedicellum versus rotundatis vel angustatis, leniter vel non constrictis; tunica pallide cinnamomeo-brunnea,  $1\text{--}1.5 \mu$  cr., angulis superioribus cellulae inferioris, praecipue uno latere, magnopere et apice ad  $9\text{--}12 \mu$  incrassata, levi; pedicello hyalino, forti, sporam aequante vel saepius brevior.

*Baccharis* sp. Reserva Florestal, Itatiaya, Rio de Janeiro, Brazil, May 7, 1922, 1814.

This species has all the appearance of a micro-form and seems amply distinct. The spore measurements suggest *P. Baccharidis-cylindrica* P. Henn., but in that species the spores are oblong, somewhat broader, and with very long pedicels.

398. ***Puccinia indagata*** Jackson & Holway, sp. nov.

O. Pycnidiis amphigenis sed plerumque epiphyllis, crebre gregariis, areas flavescentes subhypertrophicas occupantibus, punctiformibus, ellipsoideis vel oblongis,  $105\text{--}150 \mu$  latis,  $165\text{--}180 \mu$  altis; periphysibus non extrusis, superficie hospitis late fasciculatis.

I. Aecidiis epiphyllis, pycnidia circumdantibus, parvis, profunde insidentibus, matricibus inflatis diu velatis, poro apertis; aecidiosporis ellipsoideis,  $22-27 \times 30-35 \mu$ ; tunica hyalina,  $1.5-2.5 \mu$  cr., prominenter sparsiusque echinulata, poris obscuris praedita.

III. Teleutosoris hypophyllis, paucis, sparsis, pallide castaneo-brunneis, parvis,  $0.2-0.4$  mm. diam., tardius nudis, applanatis, epidermide rupta cinctis; teleutosporis ellipsoideis, oblongis vel subclavatis,  $19-25 \times 42-62 \mu$ , supra rotundatis vel obtusis, infra rotundatis vel quandoque subangustatis, leniter vel non septo constrictis; tunica aurato- vel pallide cinnamomeo-brunnea,  $1-1.5 \mu$  cr., apice ad  $4-6 \mu$  incrassata; pedicello hyalino, sporam aequante vel brevior.

*Baccharis* sp. Alto da Serra, São Paulo, Brazil, Feb. 5, 1922, 1537 (type); São Paulo, Brazil, Feb. 15, 1922, 1559.

This is another of the several species which we have encountered having echinulate aeciospore wall markings. It is most closely related to *P. albula*, from which it differs in having teliospores with apices considerably thickened and aeciospores with thicker walls.

399. ***Puccinia inopina*** Jackson & Holway, sp. nov.

O. Pycnidiis amphigenis, plerumque epiphyllis, in greges parvos laxè aggregatis, maculis flavidis insidentibus, punctatis, profunde insitis, magnis, globosis, pyriformibus vel depresso globosis,  $150-210 \mu$  altis,  $180-210 \mu$  latis; periphysibus brevibus.

I. Aecidiis amphigenis sed plerumque epiphyllis, circum pycnidia aggregatis, in maculis flavidis insidentibus, circum hypertrophicis, magnis,  $300-400 \mu$  diam., bullatis; peridio nullo; aecidiosporis late ellipsoideis,  $22-26 \times 30-40 \mu$ , una vel utraque fine saepe subacutis; tunica hyalina,  $2.5-4 \mu$  cr., finibus quandoque crassiuscula, parum tenuiter crebreque verrucoso-rugosa, striis longitudinalibus instructa.

III. Teleutosoris hypophyllis, sparsis, parvis,  $0.2-0.4$  mm. diam., mox nudis, pallide castaneo-brunneis, dein germinando cinereis, primum compactis, demum pulvinatis; epidermide rupta non visibili; teleutosporis ellipsoideis vel subclavatis,  $24-29 \times 60-75 \mu$ , supra rotundatis, infra rotundatis vel subangustatis, septo ut plurimum valde constrictis; pariete pallide cinnamomeo- vel aurato-brunneo, tenui  $1 \mu$ , ad apicem usque  $3-4 \mu$  crassato, levi; pedicello hyalino,  $6-9 \mu$  diam., sporam aequante vel duplo superante.

*Baccharis dracunculifolia* DC. Cochabamba, Bolivia, March 11, 1920, 394.

*Baccharis feindalensis* H.B.K. Quito, Ecuador, Aug. 18, 1920, 917 (type).

While resembling somewhat *P. Ancizari* Mayor, this species seems to be amply distinct. It differs from that species chiefly in aeciospore characters. In *P. Ancizari* the aeciospore wall is thinner and the markings are best described as prominently verrucose-tuberculate. The teliospores are somewhat narrower than in our species, and thickened  $5-8\mu$  at the apex, with greater thickening in the upper angles of the lower cell.

The collection on *B. dracunculifolia* bears teliospores only, and is referred here on account of the close correspondence in teliospore characters.

399a. ***Puccinia interjecta*** Jackson, nom. nov.

*Puccinia Ancizari* Arth. N. Am. Fl. 7: 476. 1921 (Not Mayor, 1913).

*Allodus Ancizari* Arth. & Orton, N. Am. Fl. 7: 476. 1921.

In connection with the study of the South American *Baccharis* rusts, the writer has had occasion to study a collection made in Guatemala and reported by Arthur (Am. Jour. Bot. 5: 529. 1918) as *Puccinia Ancizari* Mayor. The collection was made by the late E. W. D. Holway at Cerro Quemado, Quezaltenengo, Guatemala, Jan. 21, 1915 (No. 103).

This collection was compared with the type of *P. Ancizari* Mayor, and found to be distinct. In *P. Ancizari* the aeciospore wall is prominently and closely verrucose-tuberculate, while in the Guatemala collection the aeciospore wall is finely echinulate. The name, *Puccinia interjecta*, is proposed for the rust on the collection mentioned above. A description drawn exclusively from the Guatemalan material will be found in the North American Flora (l.c.).

This species is one of a group occurring on *Baccharis* which have epiphyllous aecia and aeciospores with echinulate wall markings. The teliospore characters correspond most closely to those of *P. expetiva*, but the aeciospores are quite different, having wall markings finely echinulate and moderately spaced. In the latter the aeciospore wall markings are strong and sparsely spaced.

**400. *Puccinia perincerta* Jackson & Holway, sp. nov.**

O. Pycnidiis non visis (probaliter praesentibus).

I. Aecidiis cauliculis, in ramis minoribus bullulas fusiformes vel irregulares saepe 2-4 cm. longas efficientibus, rotundatis vel oblongis, magnis, bullatis, mox dehiscentibus, peridio carentibus, pulverulentis, e matricibus ruptis emergentibus; aecidiosporis subglobosis vel late ellipsoideis,  $24-30 \times 30-45 \mu$ , una fine quandoque acutis; tunica hyalina,  $1-1.5 \mu$ , minutissime crebreque verrucosa, non vel raro striata.

III. Teleutosoris amphigenis sed plerumque hypophyllis, sparsis vel gregariis, rotundatis, 0.4-1.0 mm. diam., mox nudis, castaneo-brunneis, dein e germinatione cinereis, compactis, pulvinatis; epidermide rupta non conspicua; teleutosporis cylindraceis vel subclavatis,  $24-30 \times 60-80 \mu$ , supra rotundatis, infra rotundatis vel subangustatis, septo plerumque valde constrictis; tunica pallide cinnamomeo- vel aurato-brunnea,  $2-3 \mu$  cr., apice usque ad  $6-9 \mu$  incrassata, tereti; pedicello hyalino, forti; parietibus apice  $3 \mu$  cr., quandoque subinflatis.

*Baccharis tridentata* Vahl. Viña del Mar, Chile, Sept. 6, 1919, 11 (type).

*Baccharis* (Near *B. alaternoides* H.B.K.) Termas de Chillán, Chile, Jan. 4, 1920, 273.

*Puccinia perincerta* forms one of a series of species having teliospores with evident thickening at the apex, the length of which averages over  $60 \mu$ . All appear to be without uredinia. The several species are most easily separated by aeciospore characters. The teliospores of this species differ from *P. inopina* and *P. Ancizari* in that the side walls of the teliospores are  $2-3 \mu$  thick. In *P. Ancizari* the aeciospore wall is strongly verrucose-tuberculate, while in our species the markings are finely and closely verrucose, and not conspicuously arranged in lines as in *P. inopina*.

**401. *Puccinia perspicabilis* Jackson & Holway, sp. nov.**

O. Pycnidiis non visis, verisimiliter carentibus.

III. Teleutosoris hypophyllis, crebre gregariis et saepe in greges 1-3 mm. diam. plus minusve confluentibus, maculis decoloratis insidentibus, parvis, rotundatis, 0.2-0.4 mm. diam., mox nudis, pallide castaneo-brunneis, subpulverulentis; epidermide rupta inconspicua; teleutosporis ellipsoideis, oblongis vel clavatis,  $18-23 \times 38-60 \mu$ , supra rotundatis, infra pedicellum versus ro-

tundatis vel contractis, septo non vel leniter constrictis; tunica tenui, 1–1.5  $\mu$ , aurato-brunnea, apice leniter ad 2.5–4  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel brevior.

*Baccharis* sp. Guayaquil, Ecuador, July 31, 1920, 797.

The teliospores of this species are like those of *Puccinia exornata* Arth., but the grouping of the telial sori is very different. The aspect is that of a micro-form, and is, perhaps, to be interpreted as a correlated species.

402. *Puccinia pervenusta* Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis vel gregariis, irregulariter rotundatis, 0.2–0.5 mm. diam., profunde insidentibus, tarde nudis, soro flavescenti instructis, pulverulentis, epidermide fissa cinctis; uredosporis pyriformibus vel obovoideis, 22–27  $\times$  32–48  $\mu$ , supra rotundatis sed infra ad pedicellum plerumque angustatis; tunica hyalina, 2–3  $\mu$  cr., supra ad 3.5  $\mu$  leniter incrassata, minute verrucoso-rugosa, in lineis interruptis longitudinalibusque 2.5–4  $\mu$  inter se remotis striata, poris obscuris praedita.

III. Teleutosoris non visis; teleutosporis uredosoris immixtis, ellipsoideis vel oblongis, 26–30  $\times$  58–70  $\mu$ , supra rotundatis, infra rotundatis angustatisve, septo fortiter constrictis; tunica aurato-brunnea, 2–3  $\mu$  cr., apice leniter incrassata ad 3.5–4  $\mu$ , levi; pedicello hyalino, sporam aequante vel longiore.

*Baccharis* sp. Hacienda La Florida, Sur Yungas, Bolivia, May 27, 1920, 663.

Among the numerous rusts on *Baccharis* this species is easily distinguished by the longitudinally striate markings on the walls of the urediniospores. The uredinia appear remarkably like the caeomoid aecia of some other species, but the spores are borne on pedicels. No aecia or pycnia could be found in our material. Only a few teliospores were found in the uredinia and the description may prove inadequate.

403. *Puccinia praeculta* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis vel costis suffultis, in greges parvos crebre aggregatis, maculis primum flavidis dein decoloratis insidentibus, prominentibus, punctiformibus, globosis vel depresso globosis vel conicis, 100–150  $\mu$  altis, 135–150  $\mu$  latis; periphysibus fasciculum laxum 40–60  $\mu$  altum efformantibus.

1. Aecidiis ut plurimum hypophyllis sed saepe costis suffulcietibus amphigenis, singulatim vel in greges 2 ampliusve dispositis,

magnis, caeomatiformibus, 0.8–1 mm. diam., plerumque non profunde insidentibus, soro albedo instructis, pulverulentis, tarde nudis, epidermide inflata diu tectis, irregulariter apertis; aecidiosporis anguste ellipsoideis vel obovatis,  $18-24 \times 30-42 \mu$ , quandoque longioribus; tunica hyalina,  $2-2.5 \mu$  cr., apice adparenter ad  $3-6 \mu$  incrassata, crassissime rugosa, plicis prominulis inter se  $3-5 \mu$  remotis instructa.

III. Teleutosoris hypophyllis, sparsis vel gregariis, rotundatis, 0.3–0.8 mm. diam., nitide castaneo-brunneis, deinde ob germinationem cinereis, mox nudis, applanatis, dein pulvinatis; epidermide rupta non visibili; teleutosporis ellipsoideis vel clavatis, saepe irregularibus,  $21-27 \times 40-50 \mu$ , supra rotundatis, infra pedicellum versus rotundatis vel angustatis, non vel vix constrictis, tunica pallide castaneo-brunnea  $1.5-2.5$  cr. apice ad  $5-9 \mu$  incrassata levi praeditis; pedicello hyalino, sporam aequante vel brevior, quandoque lateraliter inserto.

*Baccharis* sp. San Felipe, Sur Yungas, Bolivia, May 21, 1920, 635.

A very distinct species, separable from all others which we have examined by the very prominent, sparsely placed, longitudinal ridges on the aeciospore wall. These ridges sometimes extend the length of the spore without interruption, or may be made up of interrupted, elongated markings. They may be strictly longitudinal or oblique, giving a somewhat spiral effect.

404. ***Puccinia praedicabilis*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, punctiformibus, paucis in omni grege dispositis, maculis flavescentibus insitis, magnis, globosis,  $150-170 \mu$  diam.; periphysibus breviter fasciculatis.

I. Aecidiis hypophyllis, caeomatiformibus, mox nudis, magnis, 0.5–1 mm. diam., pulverulentis, soro flavescenti instructis, epidermide rupta cinctis; aecidiosporis ellipsoideis,  $19-25 \times 30-36 \mu$ ; tunica hyalina,  $2-2.5 \mu$  cr., minute crebreque verrucosa, verrucis non in lineis dispositis praedita.

III. Teleutosoris hypophyllis, sparsis, rotundatis, 0.2–0.4 mm. diam., nitide aurato-brunneis, dein germinationis causa cinereis, compactis, pulvinatis; epidermide rupta non visibili; teleutosporis oblongis vel subclavatis,  $22-27 \times 65-90 \mu$ , supra rotundatis vel obtusis, infra pedicellum versus paulatim contractis, plerumque medio visibiliter constrictis; tunica tenui,  $1.5-2 \mu$ , lateribus pori apicalis ad  $3.5 \mu$  lentissime incrassata, levi; pedicello hyalino, sporam aequante sed ut plurimum brevior.



*Baccharis cassinefolia* DC.? Hacienda La Florida, Prov. Sur Yungas, Bolivia, May 26, 1920, 661.

This species is one of a group including *P. Henningsii* and *P. Mayerhansii*, having teliospores with essentially colorless walls, not appreciably thickened at the apex. This species differs from the former in spore size and from the latter in having the aeciospores finely verrucose rather than coarsely so. It also lacks uredinia, which are present in *P. Mayerhansii*.

405. ***Puccinia praedicta*** Jackson & Holway, nom. nov.

*Uredo Baccharidis* Speg. Anal. Soc. Cient. Argent. 17: 121. 1884 (Not *P. Baccharidis* Dietel & Holway).

*Uredo baccharidicola* Speg. Rev. Argent. Bot. 1: 133. 1925 (Not *P. baccharidicola* P. Henn.).

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*Baccharis serrulata* DC. Taipas, São Paulo, Brazil, Feb. 7, 1922, 1543; Guarulhos, São Paulo, Brazil, Jan. 30, 1922, 1515; Tremembé, São Paulo, Brazil, Jan. 24, 1922, 1498.

*Baccharis* sp. (Near *B. serrulata*) Campos do Jordão, São Paulo, Brazil, Apr. 28, 1922, 1780; Petropolis, Rio de Janeiro, Brazil, Oct. 18, 1921, 1230.

*Uredo Baccharidis* Speg. (1884) was based on two collections made by Balansa (3434 and 3437), in Paraguay, on *Baccharis* sp. This name was found untenable, as there was already a *Uredo Baccharidis* Lév. (1846), and Spegazzini, in 1925, renamed the species *Uredo baccharidicola*. At that time he records the above collections and others (one of which was collected in São Paulo, Brazil (Usteri 10)) as on *Baccharis serrulata*. Our collections, part of which are on *B. serrulata*, bear urediniospores which agree well with Spegazzini's description. Most of the collections also bear teliospores. Aecia do not occur so far as could be determined. The arrangement of the uredinia suggests a brachy form, but pycnia could not be found. A diagnosis of uredinia and telia drawn from the collections listed above follows:

II. Uredinia amphigenous, scattered or more commonly gregarious on yellowish spots and then chiefly epiphyllous, often arranged concentrically, round, 0.2–0.8 mm. across, yellowish, tardily naked, pulverulent, ruptured epidermis conspicuous; ure-

diniospores obovoid, 22–24 by 26–33  $\mu$ ; wall colorless or slightly tinted, 2–2.5  $\mu$ , finely and rather sparsely echinulate; pores obscure.

III. Telia hypophyllous, scattered, small, round, 0.2–0.6 mm. across, light chestnut brown, becoming cinerous through germination, early naked, appanate becoming pulvinate, ruptured epidermis usually not noticeable; teliospores ellipsoid, oblong or subclavate, 20–22 by 33–44  $\mu$ , rounded above, rounded or occasionally narrowed to pedicel below, not or slightly constricted at septum; wall thin 1–1.5  $\mu$ , cinnamon brown, thickened at the angles in the upper cell and 5–7  $\mu$  at apex, smooth; pedicel colorless, equalling the spore or shorter.

The species suggests *P. montserrates* Mayor, but differs in several characters. The teliospores of that species have thicker, darker colored walls and the urediniospores are considerably larger and the echinulate markings more closely placed.

406. ***Puccinia ruderaria*** Jackson & Holway, sp. nov.

(I, I. Pycnidiis et aecidiis praesentibus (*vide* infra).

II. Uredosoris amphigenis, sparsis, flavidis, rotundatis, 0.2–0.8 mm. diam., tarde nudis, pulverulentis, epidermide rupta conspicue cinctis; uredosporis obovatis, 16–20  $\times$  26–34  $\mu$ ; tunica 1.5–2.5  $\mu$  cr., hyalina vel pallide aurato-brunnea, minute echinulata, verrucis moderate inter se remotis praedita; poris obscuris.

III. Teleutosoris hypophyllis, sparsis, rotundatis, 0.2–0.4 mm. diam., pallide castaneo-brunneis, germinando cinerascentibus, tardius nudis, compactis, primum appanatis, dein subpulvinatis, epidermide rupta primo conspicue cinctis; teleutosporis ellipsoideis vel subclavatis, 20–26  $\times$  42–60  $\mu$ , supra rotundatis sed infra plerumque contractis, septo non vel leniter constrictis; tunica aurato- vel pallide castaneo-brunnea, apice plerumque pallidiores, 1–1.5  $\mu$ , apice ad 6–9  $\mu$  late incrassata, levi; pedicello hyalino, sporam aequante vel dimidio superante.

*Baccharis oxyodonta* DC. Pico Tijuca, Rio de Janeiro, Brazil, Dec. 25, 1921, 1425.

*Baccharis* (Near *B. oxyodonta* DC.) Rio de Janeiro, Brazil, Aug. 23, 1921, 1063, Nov. 11, 1921, 1291 (type); Ouro Preto, Minas Geraes, Brazil, Dec. 9, 1921, 1376; Barbacena, Minas Geraes, Brazil, Dec. 12, 1921, 1382, Dec. 14, 1921, 1397, 1398.

These collections were at first referred to *P. evadens*. The teliospores are, however, much narrower. A few old aecia were found, too old for adequate description, which, however, served to make clear that the species was quite different from *P. evadens*. The aeciospores are 20–24 by 28–35  $\mu$ , with colorless walls, prominently tuberculate-rugose.

The species is somewhat like *P. salebrata*. The aeciospores of that species are, however, much more coarsely tuberculate.

407. ***Puccinia salebrata*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, numerosis, in maculis decoloratis laxè aggregatis, globosis vel ellipsoideis, 90–120  $\mu$  altis, 100–120  $\mu$  latis; periphysibus breviter laxè fasciculatis.

I. Aecidiis hypophyllis, crebre aggregatis, parvis, bullatis, poro apertis; aecidiosporis ellipsoideis, 22–28  $\times$  32–36  $\mu$ ; tunica hyalina, adparenter tenui, crassissime tuberculato-rugosa, verrucis 3–5  $\mu$  altis et una fine adparenter altioribus praedita.

II. Uredosoris hypophyllis, sparsis, parvis, rotundatis, 0.3–50 mm. diam., albidis vel flavidis, tarde nudis, pulverulentis, epidermide rupta cinctis; uredosporis ellipsoideis, 23–26  $\times$  30–34  $\mu$ ; tunica hyalina vel leniter tineta, 1.5–2  $\mu$ , tenuiter crebreque echinulata, poris obscuris instructa.

III. Teleutosoris hypophyllis, sparsis, rotundatis, 0.3–0.8 mm. diam., mox nudis, applanatis, dein pulvinatis, splendide castaneo-brunneis, germinationis causa cinerascentibus; epidermide rupta non visibili; teleutosporis ellipsoideis, oblongis vel subclavatis, 22–28  $\times$  45–60  $\mu$ , supra rotundatis, infra pedicellum versus rotundatis vel attenuatis, septo non vel leniter constrictis; tunica obscure cinnamomeo-brunnea, 1–2  $\mu$  cr., apice ad 6–9  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel brevior.

*Baccharis* sp. San Felipe, Prov. Sur Yungas, Bolivia, May 19, 1920, 624.

The characters indicate close relationship with *P. Baccharidis-triplinervis* P. Henn., as represented by Ule 1449, and another unnumbered collection made at the type locality, dated 1883 (See species No. 380, page 128). In our collection the urediniospores and teliospores average considerably larger and the aeciospores are much more prominently tuberculate. The urediniospore wall is thinner and the echinulate markings somewhat more closely placed.

Material of aecia in *P. salebrata* is scanty and old, admitting

only an incomplete description. The aeciospores are, however, quite remarkable. The markings are exceedingly coarse, often elongated and rather closely placed. They appear to be 3–4  $\mu$  high at the sides of the spore, and longer at one end, giving the appearance of a wall thickened at the apex. The thickness of the wall itself could not be determined with certainty.

408. *PUCCINIA UNICOLOR* Arth. Bot. Gaz. 65: 472. 1918.

*Baccharis pulchella* Sch. Bip. La Paz, Bolivia, March 19, 1920, 428, March 24, 1920, 452; Cuzco, Peru, June 30, 1920, 742.

*Baccharis* sp. Cochabamba, Bolivia, March 10, 1920, 385; La Paz, Bolivia, March 26, 1920, 469.

Aecia are present in collections 428, 472 and 385. These are accompanied by yellowish, epiphyllous pycnia. The aecia are hypophyllous, large and caeomoid. The aeciospores are ellipsoid, often somewhat pointed at one or both ends, 21–24 by 30–42  $\mu$ . The wall is colorless and finely verrucose, with markings arranged in lines.

This species, originally described from material collected at Cuzco, Peru, on *Baccharis hemiprionodes* Buek., is so close to *P. sphenica* Arth. from Mexico, that I have been unable to detect any difference in uredinia and telia. It seems best, however, to list it separately until aecia of *P. sphenica* are known. One of the collections, 742, was collected near the type locality.

*P. preandina* Speg. has been recorded on *B. pulchella* from Argentina. This species, however, differs in several features.

409. *Uredo illaudanda* Jackson & Holway, sp. nov.

II. Uredosoris amphigenis, sparsis vel gregariis, magnis, rotundatis vel ellipticis, 0.4–1.2 mm. diam., tarde nudis, subpulverulentis, castaneo-brunneis, epidermide rupta cinctis; uredosporis oblongis vel anguste obovatis, 18–22  $\times$  22–42  $\mu$ ; tunica castaneo-brunnea, 2–2.5  $\mu$  cr., minute crebreque echinulata, ad apicem verrucis prominentioribus praedita, basi levi vel fere levi; poris 8, duos annulos paulo infra et supra aequatorem situs occupantibus, in utroque annulo poris 4 dispositis.

*Baccharis* sp. Pichilemu, Chile, Oct. 12, 1919, 109.

A well marked species distinguished by the presence of eight wall pores in two bands, and by the closely set, finely echinulate

wall markings, more prominent at apex and disappearing at the base of the spore.

410. **Uredo temucensis** Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis, magnis, rotundatis vel oblongis, saepe irregularibus, 0.5–1.5 mm. diam., tarde nudis, ex obscure cinnamomeo-castaneo-brunneis, pulverulentis, epidermide inflata et irregulariter rumpente diu tectis; uredosporis ellipsoideis vel obovatis, 20–22  $\times$  30–38  $\mu$ ; tunica aurato-brunnea, 1.5–2  $\mu$  cr., minutissime et obscure echinulata, verrucis inter se moderate remotis praedita, circa poros levi; poris 3, prominentibus, subaequatorialibus.

*Baccharis* sp. Temuco, Chile, Dec. 5, 1919, 201.

SPECIES ON CARDUACEAE

(Tribe Inuleae)

411. **Puccinia Achyroclines** (P. Henn.) Jackson & Holway, comb. nov.

*Uredo Achyroclines* P. Henn. Hedwigia Beibl. 38: 70. 1899.

*Achyrocline satureioides Vargusiana* (DC.) Baker, Petropolis, Rio de Janeiro, Brazil, Oct. 29, 1921, 1254; Tremembé, São Paulo, Brazil, March 6, 1922, 1614.

*Achyrocline Vautheriana* DC. Tijuca, Rio de Janeiro, Brazil, Aug. 19, 1921, 1057.

*Achyrocline* sp. Guarulhos, São Paulo, Brazil, Jan. 30, 1922, 1513; La Falda, Argentina, Aug. 14, 1922, 2022.

The uredinia and urediniospores of this species agree well with the description of *Uredo Achyroclines* P. Henn., which was recorded as occurring on *Achyrocline satureioides* from St. Catharina, Brazil.

Teliospores are present in collection 1614. These occur in hypophyllous sori, light chestnut brown in color, obscured by the tomentum of the host. The teliospores are clavate 18–21 by 38–50  $\mu$ , rounded above, narrowed and truncate below. The wall is thin, 1–1.5  $\mu$ , light golden brown, nearly colorless below, broadly and gradually thickened at the apex 6–9  $\mu$ . The pedicel is colorless, broad at point of attachment, equalling the spore or shorter.

412. *PUCCINIA GNAPHALIATA* (Schw.) Arth. & Bisby, Proc. Am. Phil. Soc. **57**: 221. 1918.

*Caeoma (Aecidium) gnaphaliatum* Schw. Trans. Am. Phil. Soc. II, **4**: 292. 1832.

*Puccinia investita* Schw. Trans. Am. Phil. Soc. II, **4**: 296. 1832.

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*Achyrocline glandulosa* Blake, Cuenca, Ecuador, Sept. 12, 1920, 982.

*Achyrocline hyperchlora* Blake, Cochabamba, Bolivia, March 14, 1920, 406.

*Achyrocline polycephala* Rusby, Hacienda La Florida, Sur Yungas, Bolivia, May 30, 1920, 681.

*Achyrocline ramossissima* Britton, La Paz, Bolivia, March 26, 1920, 468.

*Gnaphalium paniculatum* DC.? Cuzco, Peru, July 2, 1920, 754.

*Gnaphalium* sp. La Falda, Argentina, Aug. 14, 1922, 2024.

This species seems not to have been reported previously from South America, but the rust on the specimens listed seems to agree sufficiently well to be so included. The species is known in the North Eastern United States, and in Arizona, California, Mexico and Guatemala. The collections listed above extend the range down the west coast of South America to Argentina.

413. *PUCCINIA GNAPHALII* (Speg.) P. Henn. Hedwigia Beibl. **41**: 66. 1902.

*Uredo Gnaphalii* Speg. Anal. Soc. Ci. Argent. **12**: 73. 1881.

*Puccinia gnaphaliicola* P. Henn. Hedwigia Beibl. **38**: 68. 1899.

*Puccinia Gnaphalii* Speg. Anal. Mus. Nac. Buenos Aires **19**: 309. 1909.

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*Gnaphalium purpureum* L. Alto da Serra, São Paulo, Brazil, Jan. 28, 1922, 1503.

*Gnaphalium spicatum* Lam. San Felipe, Sur Yungas, Bolivia, May 22, 1921, 638; Quito, Ecuador, Aug. 15, 1920, 900.

*Gnaphalium spathulatum* Lam. Papudo, Chile, Sept. 20, 1919, 55.

Originally described from Argentina, this species has previously

been reported from Chile and Brazil. It is also known from Guatemala, and the South Eastern United States.

414. PUCCINIA PLUCHEAE (Sydow) Arth. Bull. Torrey Club **49**: 194. 1922.

*Uredo Pluchae* Sydow, Ann. Myc. **1**: 333. 1903.

*Uredo biocellata* Arth. Bull. Torrey Club **33**: 517. 1906.

*Puccinia biocellata* Vesterg. Micr. Rar. Sel. **1267**. 1908.

*Uredo Pluchae* Speg. Anal. Mus. Nac. Buenos Aires **19**: 319. 1909.

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*Pluchea odorata* (L.) Cass. Cochabamba, Bolivia, March 4, 1920, 365; Sorata, Bolivia, Apr. 25, 1920, 571.

*Pluchea Quitoc* DC. Rio de Janeiro, Brazil, Aug. 23, 1921. 1062, Nov. 11, 1921, 1292.

This widely distributed species was originally described<sup>7</sup> from Florida. It is known throughout the West Indies and in Guatemala. In South America it is otherwise known only from Argentina. The specimens from Bolivia bear uredinia and telia.

415. PUCCINIA TESSARIAE (Speg.) Dietel, Ann. Myc. **5**: 246. 1907.

*Uredo Tessariae* Speg. Anal. Soc. Ci. Argent. **12**: 75. 1881.

*Uredo scopigena* P. Henn. Hedwigia **43**: 160. 1904.

*Puccinia Tessariae* Speg. Anal. Mus. Nac. Buenos Aires **19**: 305. 1909.

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*Tessaria absinthioides* DC. Baños de Cauquenes, Chile, Jan. 14, 1920, 296.

416. UROMYCES MEGALOSPERMUS Speg. Anal. Mus. Nac. Buenos Aires **6**: 218. 1899.

*Tessaria integrifolia* R. & P. Choisica, above Lima, Peru, July 22, 1920, 778.

Originally described from Argentina, this species is also known from Colombia.

## SPECIES ON CARDUACEAE

## (Tribe Heliantheae)

417. *AECIDIUM ENCELIAE* Arth. Bot. Gaz. **65**: 472. 1918.

*Encelia canescens* Lam. Arequipa, Peru, July 10, 1920, 768.

This is the second collection of this striking systemic *Aecidium* of which we have any knowledge. It was made at the same locality and on the same host as the type collection.

418. *PUCCINIA ABRUPTA* Dietel & Holway; Dietel, Hedwigia **37**: 208. 1898.

*Puccinia subglobosa* Dietel & Holway; Holway, Bot. Gaz. **31**: 332. 1901.

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*Verbesina semidecurrens* Kuntze, Sorata, Bolivia, Apr. 13, 1920, 515.

*Verbesina* sp. Urubamba, Urubamba Valley, Cuzco, Peru, July 3, 1920, 758A.

*Viguiera aurea* (H.B.K.) Hieron. Huigra, Chimborazo, Ecuador, Aug. 3, 1920, 827.

*Viguiera australis* Blake, Cochabamba, Bolivia, March 12, 1920, 402.

*Viguiera lanceolata* Britton, Hacienda La Florida, Sur Yungas, Bolivia, May 27, 1920, 664.

*Viguiera pazensis* Rusby, Cochabamba, Bolivia, Feb. 25, 1920, 316, March 1, 1920, 354; La Paz, Bolivia, March 26, 1920, 466, March 31, 1920, 486; Sorata, Bolivia, Apr. 11, 1920, 499, Apr. 21, 1920, 559; Villa Aspiazu, Sur Yungas, Bolivia, May 31, 1920, 685.

*Viguiera Pflanzii* Perk. La Paz, Bolivia, March 23, 1920, 444, May 12, 1920, 599; Sorata, Bolivia, Apr. 14, 1920, 522; Cuzco, Peru, July 2, 1920, 753; Arequipa, Peru, July 11, 1920, 773.

*Viguiera quitensis* (Benth.) Blake, Quito, Ecuador, Aug. 13, 1920, 881, Aug. 21, 1920, 933.

*Viguiera retroflexa* Blake, Hacienda Anacuri, Nor Yungas, Bolivia, June 4, 1920, 716.

The above collections are referred to this species with some hesitation. Those on *Viguiera* are quite certainly all one spe-



cies, though showing some variation. All have two subequatorial pores in the urediniospore wall. The type of the species is based on material from Mexico on *Viguiera helianthoides* H.B.K. Our collections have urediniospores with somewhat thinner walls and more closely echinulate. Material on some other species of *Viguiera* from Mexico fits our material very well.

It is still an open question whether any *Verbesina* rusts are properly referred to this species. The same treatment is followed here as was done in the preparation of the species on these host genera for the North American Flora. The group is a difficult one and needs re-study with all the type material available.

419. PUCCINIA ACANTHOSPERMI P. Henn. Hedwigia 41: 296. 1902.

*Acanthospermum australe* (L.) Kuntze, Novo Friburgo, Rio de Janeiro, Brazil, Jan. 1, 1922, 1438; São Bernardo, São Paulo, Brazil, Jan. 20, 1922, 1486.

Described originally on *A. xanthioides*, this species has been reported only twice before, and both collections have been from the same region in which those listed above were taken.

420. *Puccinia boliviana* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, crebre gregariis, in greges 3-5 confertis, maculis flavidis et subhypertrophicis insidentibus, paucis, prominentibus, punctatis, globosis vel ellipsoideis, 135-150  $\mu$  latis, 150-180  $\mu$  altis; periphysibus non prominentibus.

I. Aecidiis epiphyllis vel in nervis amphigenis, circum gregem pycnidiorum gregariis, soro flavescenti praeditis; peridio albo, prominenti, membranaceo, cylindraceo, 2 mm. alto, tandem lacerato; loculis peridialibus e facie visis polygonis, 22-28  $\times$  45-60  $\mu$ , tunica hyalina crebre minuteque verrucosa instructis; aecidiosporis parum angulato-ellipsoideis vel globosis, 20-24  $\times$  25-32  $\mu$ ; pariete aurato-flavo, 1.5-2.5  $\mu$ , una fine quandoque crassiore, 3-3.5  $\mu$ , crebrius minuteque, saepe una fine valde, verrucoso-tuberculato.

II. Uredosoris hypophyllis, sparsis, cinnamomeo-brunneis, parvis, rotundatis, 0.2-0.4 mm. diam., mox nudis, pulverulentis, epidermide rupta inconspicuis; uredosporis late depresso sphaeroideis sed adparenter e latere ellipsoideis 20-22  $\times$  24-26  $\mu$  et longitudinaliter visis globosis; tunica pallide cinnamomeo-brunnea, 1-1.5  $\mu$  cr., minute crebriusque echinulata; poris 2, utraque fine axis longi aequatorialibus.

III. *Teleutosoris hypophyllis*, sparsis, castaneo-brunneis, germinando cinerascentibus, parvis, rotundatis, 0.2–0.5 mm. diam., mox nudis, compactis, pulvinatis; epidermide fissa non visibili; teleutosporis lineari-oblongis vel elongato-clavatis,  $15-21 \times 60-100 \mu$ , supra rotundatis vel obtusis, infra rotundatis vel saepius contractis, septo plerumque visibiliter constrictis; tunica pallide aurato-brunnea, infra pallidior,  $1-1.5 \mu$  cr., apice ad  $6-12 \mu$  incrassata, levi; pedicello incolori, sporam aequante vel saepius brevior.

*Oyedaea boliviana* Britton, Hacienda La Florida, Sur Yungas, Bolivia, May 29, 1920, 676 (type); Villa Aspiazu, Sur Yungas, Bolivia, May 31, 1920, 691, June 1, 1920, 696; Hacienda Anacuri, Nor Yungas, Bolivia, June 3, 1920, 701.

*Oyedaea* sp. Coroico, Nor Yungas, Bolivia, June 12, 1920, 732.

This is one of a series of three species having very similar teliospores, but which are strikingly different in urediniospore characters. The first one to be described is *Puccinia Oyedaeae* Mayor, on *Oyedaea* sp. from Colombia. Only the teliospores were observed by Mayor, who interpreted the species as a leptiform. Urediniospores were, however, found in the type material. The second species was collected in Costa Rica by E. W. D. Holway, and assigned by Arthur in error to *P. Oyedaeae* Mayor. (See discussion under species No. 423a, page 163.) The three species may be distinguished as follows:

- |   |                             |
|---|-----------------------------|
| Urediniospores with two equatorial pores.....   | 420. <i>P. boliviana</i> .  |
| Urediniospores with several pores.  |                             |
| Urediniospores oblate sphaeroid $18-21 \mu$ diam., walls<br>echinulate, thin.....             | <i>P. Oyedaeae</i> .        |
| Urediniospores globoid or ellipsoid $23-27 \times 26-32 \mu$ ,<br>walls verrucose, thick..... | 423a. <i>P. Holwayula</i> . |

421. *PUCCINIA CALEAE* Arth. Bot. Gaz. 40: 201. 1905.

*Calea cuneifolia* DC. São Bernardo, São Paulo, Brazil, Jan. 20, 1922, 1485; Ypiranga, São Paulo, Brazil, Feb. 23, 1922, 1591; Arthur Anvim, São Paulo, Brazil, March 15, 1922, 1631.

*Calea huigrensis* Blake, Huigra, Chimborazo, Ecuador, Aug. 7, 1920, 856.

*Calea* sp. São Bernardo, São Paulo, Brazil, Jan. 20, 1922, 1484.

This species is abundant in Central America, but does not appear to have been recorded from South America. It seems best to assign these collections as above, since we can detect no essential difference between them and others from Central America.

422. *Puccinia capitulata* Jackson & Holway, sp. nov.

O, I. Pycnidiis et aecidiis incognitis.

II. Uredosoris hypophyllis, sparsis vel gregariis, rotundatis, parvis, 0.2–0.5 mm. diam., aurato- vel cinnamomeo-brunneis, mox nudis, pulverulentissimis; epidermide rupta ut plurimum non visibili; uredosporis globosis, 23–26  $\mu$  diam.; tunica aurato-brunnea, tenui, 1–1.5  $\mu$ , crebre subtiliterque echinulata; poris obscuris sed apparenter 4–6, sparsis.

III. Teleutosoris hypophyllis, sparsis vel gregariis, rotundatis, 0.3–0.6 mm. diam., nitide castaneo-brunneis, e germinatione cinerascentibus, compactis, applanatis, demum pulvinatis; epidermide scissa non visibili; teleutosporis oblongis, 22–28  $\times$  50–80  $\mu$ , supra rotundatis vel obtusis, infra rotundatis vel quandoque subangustatis, medio valde constrictis; tunica aurato- ad pallide castaneo-brunnea, 1–1.5  $\mu$  cr., lateribus septo approximatis cellulae inferioris et apice cellulae superioris ad 6–9  $\mu$  late pallideque umbonata, levi; pedicello hyalino, sporam aequante vel plerumque brevior.

*Monopholis hexantha* Blake, Cuenca, Ecuador, Sept. 10, 1920, 973 (type).

*Monopholis Holwayae* Blake, Cuenca, Ecuador, Sept. 15, 1920, 989.

423. *Puccinia examinata* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, paucis, gregariis, maculis decoloratis parumque hypertrophicis insidentibus, punctiformibus, subepidermicis, globosis vel depresso globosis, 135–150  $\mu$  latis, 105–120  $\mu$  altis; periphysibus late humiliterque fasciculatis.

III. Teleutosoris amphigenis, in greges 1.5–3.0 mm. diam. aggregatis, maculis leniter hypertrophicis insidentibus, saepe nerviculis, irregulariter rotundatis, 0.2–0.4 mm. diam., mox nudis, theobrominis, pulverulentis, epidermide fissa cinctis; teleutosporis ellipsoideis vel subclavatis, 20–24  $\times$  34–45  $\mu$ , supra rotundatis, infra rotundatis vel attenuatis, septo valde constrictis; tunica

castaneo-brunnea, 2–2.5  $\mu$  cr., lateribus pori apicalis ad 3  $\mu$  leniter incrassata, sicca minute rugosa sed uda adparenter levi; poro cellulae superioris apicali, poro cellulae inferioris basali, hilo approximato; pedicello deciduo.

*Verbesina Hallii* Hieron. Quito, Ecuador, Aug. 19, 1920, 922.

This micro-cyclic species differs from *P. ferox* Dietel & Holway and *P. cundinamarcensis* Mayor in the thicker walls and in the position of the pore in the lower cell. In our species the pore of the lower cell is always close to the hilum.

423a. ***Puccinia Holwayula*** Jackson, nom. nov.

*Puccinia Oyedaeae* Arth. Mycologia 10: 145. 1918 (Not Mayor, 1913).

*Dicaeoma Oyedaeae* Arth. & Jackson, N. Am. Fl. 7: 431. 1921.

In connection with the study of *Puccinia boliviana* (No. 420) the writer took occasion to examine the material on which the report of *P. Oyedaeae* Mayor, from Costa Rica, was based. It was found that the Costa Rican material was very different from *P. Oyedaeae* in urediniospore characters. Mayor described only teliospores, and interpreted his species as a lepto-form. A few urediniospores are, however, present in the telia of the type material. These are depressed globoid, 18–21  $\mu$  in diameter with 5–6 pores which are apparently subequatorial, but often appear scattered. The walls are thin and moderately echinulate. The urediniospores in the Costa Rican material are very different, being much larger, thick walled, prominently and coarsely verrucose-echinulate with scattered pores.

It would appear that three very distinct species having similar teliospores occur on *Oyedaea*. For the Costa Rican species the name *Puccinia Holwayula* is proposed. The type collection is on *Oyedaea acuminata* (Benth.) Benth. & Hook. f. and was made at San Jose, Costa Rica, Jan. 3, 1916, by E. W. D. Holway (No. 356). A full and adequate description drawn exclusively from the Costa Rican material will be found in the North American Flora (*l.c.*).

A specimen on *Oyedaea verbesinoides* DC. collected at Aserri, Costa Rica, by H. Sydow, and distributed as No. 589 in Sydow, Fungi exotici exsiccati, is the same as the collection from Costa Rica mentioned above, and is to be referred to this species.

424. PUCCINIA IRREGULARIS Dietel, Hedwigia 36: 33. Feb. 1897  
(Not Ell. & Tr. June 1897).

*Verbesina boliviana* Klatt. Sorata, Bolivia, Apr. 25, 1920,  
572.

The above collection seems best referred to this species for the present. The urediniospores agree well with the type. The teliospores, however, while very similar, lack the irregular character which gave this species its name. The telia in our collection are long covered by the epidermis, which is characteristic of the species.

425. PUCCINIA MADIAE Sydow, Monog. Ured. 1: 121. 1902.

*Madia chilensis* (Nutt.) Reiche, Baños de Cauquenes, Rancagua, Chile, Jan. 15, 1920, 297.

*Madia sativa* Mol. Baños de Cauquenes, Rancagua, Chile, Jan. 13, 1920, 291; Branden Copper Mines, Rancagua, Chile, Jan. 20, 1920, 300.

*Madia* sp. Panimávida, Chile, Dec. 15, 1919, 231; Zapallar, Chile, Jan. 31, 1920, 301.

It seems best for the purposes of this account to report these collections under the above name, which was based on material from Chile, and is certainly correct. In North America, the name in present use is *P. nuda* E. & E. (See N. Am. Fl. 7: 598. 1922). It seems probable that the species should be combined with others on related hosts, as has been done for the North American collections.

426. PUCCINIA MINUSCULA Arth. Bull. Torrey Club 51: 56. 1924.

*Helianthus hypargyreus* Blake, Huigra, Chimborazo, Ecuador, Aug. 3, 1920, 815; Cuenca, Ecuador, Sept. 10, 1920, 971.

A distinct species originally reported from the same locality as the first specimen listed above, and on the same host.

427. *Puccinia obrepita* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, paucis, in maculis decoloratis subhy-pertrophicis crebre aggregatis, nigricantibus, punctiformibus, parum variabiliter globosis vel ellipsoideis, 110–180  $\mu$  latis, 135–180  $\mu$  altis; periphysibus fasciculum humilem compactumque efformantibus.

I. *Aecidiis* epiphyllis, pycnidia circumdantibus, in greges 3–8 congregatis, parvis, .35–.5 mm. diam., soro flavescenti et peridio albido conspicue adulto membranaceo lacerato praeditis; cellulis peridialibus e facie irregulariter polygonis,  $22\text{--}30 \times 36\text{--}45 \mu$ ; tunica intus extusque tenui, collabescente, intus crebre minuteque verrucosa; aecidiosporis ellipsoideis,  $18\text{--}24 \times 24\text{--}32 \mu$ , tunica pallide aurato-flava  $1.5\text{--}2 \mu$  crebre minuteque verrucoso-tuberculata instructis.

II. *Uredosoris* hypophyllis, sparsis, parvis, rotundatis, 0.2–0.4 mm. diam., mox nudis, pulverulentis, cinnamomeo-brunneis, epidermide rupta plerumque visibiliter cinctis; uredosporis late depresso sphaeroideis, infra ut plurimum leniter depressis,  $22\text{--}24 \mu$  altis,  $24\text{--}27 \mu$  latis; tunica castaneo-brunnea,  $2\text{--}2.5 \mu$  cr., minute echinulata, verrucis moderate inter se remotis praedita; poris 5–7, sparsis vel 4–5 in zona aequatoriali vel subaequatoriali et 1–2 supra dispositis.

III. *Teleutosoris* hypophyllis, sparsis, parvis, rotundatis, 0.2–0.6 mm. diam., castaneo-brunneis, dein germinando cinereis, mox nudis, compactis, applanatis, tandem pulvinatis; epidermide rupta in soris junioribus solis visibili; teleutosporis ellipsoideis, oblongis vel subclavatis,  $21\text{--}28 \times 42\text{--}60 \mu$ , supra rotundatis, infra rotundatis vel subangustatis, septo leniter vel non constrictis; tunica castaneo-brunnea, saepe infra pallidior,  $1.5\text{--}3 \mu$ , angulis cellulae inferioris apiceque cellulae superioris ad  $6\text{--}9 \mu$  crassata, levi; pedicello hyalino, sporam aequante vel duplo longiore vel etiam brevior.

*Wedelia isolepis* Blake, Sorata, Bolivia, Apr. 14, 1920, 517 (type).

*Wedelia* sp. Sorata, Bolivia, Apr. 25, 1920, 570.

This species is one of a series occurring in South America on *Wedelia* having several uredinial wall pores and teliospores with apices thickened appreciably at the apex. It differs from *P. subaquila* (See No. 433) in the number and arrangement of the urediniospore pores and from *P. ecuadorensis* Arth. in the much greater thickening of the apex of the teliospore wall. In the description of the latter species, the apical thickening is given as  $3\text{--}5 \mu$ . An examination of the type shows that the thickening is very slight, rarely, if ever, over  $3 \mu$ . The species is therefore very close to *P. caracasana* Sydow, which may, when carefully compared, prove to be synonymous.

The several species of *Puccinia* occurring on *Wedelia*, three of which are described in this paper, may be separated as follows:

## Uredinia present.

Urediniospore wall pores two, aecia without peridia. 435. *P. wedeliicola*.

Urediniospore wall pores three or more, aecia, where known, with well developed peridia.

Teliospores only slightly thickened at apex,  $3\ \mu$  or less.Urediniospore wall pores 4 equatorial. . . . . *P. caracasana*.Urediniospore wall pores 6 scattered. . . . . *P. ecuadorensis*.Teliospores appreciably thickened at apex,  $5\ \mu$  or more.Urediniospore wall pores 5-7 scattered. . . . . 427. *P. obrepta*.Urediniospore wall pores 3-4 equatorial. . . . . 433. *P. subaquila*.Uredinia absent; micro-form. . . . . *P. Wedeliae*.428. *Puccinia partheniicola* Jackson, nom. nov.? *Uredo Parthenii* Speg. Anal. Mus. Nac. Buenos Aires 6: 239.  
1899 (Not *P. Parthenii* Arth. 1910).

II. Uredosoris epiphyllis et cauliculis sed quandoque hypophyllis, soris foliiculis magnis rotundatis 0.4-0.8 mm. diam. saepe confluentibus sed soris cauliculis elongatis 1-5 mm. praeditis, tardius nudis, cinnamomeo-brunneis, pulverulentis, epidermide rupta cinctis; uredosporis obovatis vel cuneatis (?),  $22-24 \times 23-27\ \mu$ , pariete cinnamomeo- vel pallide castaneo-brunneo  $2-2.5\ \mu$  cr. minute moderateque echinulato instructis; poris, duobus vel tribus, subaequatorialibus vel duobus subaequatorialibus et uno apicali.

III. Teleutosoris epiphyllis vel cauliculis, uredosoris conformibus, compactis, nigricantibus; teleutosporis  $27-30 \times 30-36\ \mu$ , utrinque rotundatis, septo non constrictis; tunica theobromina,  $5-6\ \mu$  cr., ad apicem umbone lato pallidioreque usque  $9\ \mu$  incrassata, levi; pedicello hyalino, longo, persistenti, in longitudine sporam triplo vel quadruplo superante vel brevior.

*Parthenium Hysterophorus* L. Cochabamba, Bolivia, Feb. 29, 1920, 349 (type).

*Viguiera Pflanzii* Perkins, La Paz, Bolivia, March 19, 1920, 424.

In a previous publication (Mycologia 14: 109. 1922) the writer has expressed the opinion that *Puccinia Parthenii* Arth. and *Uredo Parthenii* Speg. were not synonymous. Arthur's combination was based on material collected in Mexico on *Parthenium argentatum* A. Gray. Teliospores are known in North America only on that host. The urediniospores of Mexican collections on *P. Hysterophorus* L., the type host of Spegazzini's species, are

quite different from those on *P. argentatum*. The type of *Uredo Parthenii* has, however, not been available for comparison.

In the collections listed above, one of which is on *P. Hysterophorus*, the urediniospores agree with Mexican collections on the same host. The teliospores are quite different from the teliospores on *P. argentatum*. For these reasons it seems best to use a new name for this species. It seems quite likely that *Uredo Parthenii* Speg. will prove to be synonymous, though this is not certain. The rusts on the two hosts listed above show identical characters, except that the collection on *Viguiera* consists mostly of epiphyllous and caulicolous telia, while the type collection shows mostly uredinia on the leaves and both uredinia and telia on the stems.

429. ***Puccinia Polymniae*** Jackson & Holway, sp. nov.

II. Uredosoris amphigenis sed plerumque hypophyllis, sparsis vel gregariis, rotundatis vel irregularibus, 0.2–0.8 mm. diam., castaneo-brunneis, mox nudis, pulverulentis; epidermide rupta plerumque visibili; uredosporis depresso globosis, 21–24  $\mu$  altis, 26–32  $\mu$  latis; tunica castaneo-brunnea, 1.5–2  $\mu$  cr., minute echinulata, verrucis inter se moderate remotis; poris 4, subaequatorialibus.

III. Teleutosoris hypophyllis, sparsis, rotundatis, 0.2–0.4 mm. diam., nitide castaneo-brunneis, dein germinando theobrominis cinereisque, mox nudis, compactis, applanatis, dein pulvinatis; epidermide rupta non visibili; teleutosporis parum irregulariter ellipsoideis vel clavatis, 24–30  $\times$  48–60  $\mu$ , supra rotundatis vel obtusis, infra ad basim rotundatis vel contractis, septo non vel leniter constrictis; tunica infra aurato- sed supra pallide castaneo-brunnea, 1–1.5  $\mu$  cr. in cellula inferiore sed in cellula superiore crassiore, apice paulatim ad 3–6  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel brevior.

*Polymnia glabrata* DC. Sorata, Bolivia, Apr. 21, 1920, 558 (type).

*Polymnia eurylepis* Blake, Cuenca, Ecuador, Sept. 10, 1920, 974.

A distinct species separable because of the vertically flattened urediniospores with four sub-equatorial pores. The teliospores are somewhat irregular. The pore of the lower cell is at the septum and that of the upper cell often depressed so that it appears at one side of the apical thickening.



The second collection listed bears uredinia only, the spores of which agree with the type collection.

This is probably the same species as that reported by Pennington (Anal. Soc. Cient. Argent. **53**: 264. 1902) as *Puccinia Helianthi* Schw., on *Polymnia auriculata*.

*Uredo Polymniae* P. Henn. is the uredinial stage of *Uromyces Polymniae* (P. Henn.) Dietel & Holway. A few typical teliospores are present in the type specimen. The urediniospores of that species are quite different from those in the species described above, being smaller, not depressed and with two equatorial pores.

430. *PUCCINIA SPILANTHICOLA* Mayor, Mém. Soc. Neuch. Sci. Nat. **5**: 531. 1913.

*Spilanthes ocymifolia radiifera* A. H. Moore, Nictheroy, Rio de Janeiro, Brazil, Dec. 27, 1921, 1430; Reserva Florestal, Itatiaya, Rio de Janeiro, Brazil, May 10, 1922, 1839.

*Spilanthes uliginosa* Sw. Cascadura, Rio de Janeiro, Brazil, Jan. 12, 1922, 1472.

These collections seem best referred to this species, rather than to *P. Spilanthis* P. Henn. The species has previously been reported only from Colombia. Mesospores are present, but usually not in the high proportion found in the Colombian collections.

431. *PUCCINIA SPLENDENS* Vize, Grevillea **7**: 11. 1878.

*Puccinia Franseriae* Sydow, Ann. Myc. **1**: 326. 1903.

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*Franseria artemisioides* Willd. Quito, Ecuador, Sept. 2, 1920, 957; Cuenca, Ecuador, Sept. 10, 1920, 979.

These collections seem to agree sufficiently well with the North American species to justify the identification given above. There are slight differences, but these do not seem to be sufficient to warrant separation. The species is known otherwise only from the South Western United States.

432. *Puccinia Steiractinia* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, paucis, pyriformibus vel oblongis, 165–210  $\mu$  latis, 240–270  $\mu$  altis; periphysibus late humiliterque fasciculatis.

I. Aecidiis epiphyllis, singulatim saepe sine pycnidiis vel gregatim in maculis leniter hypertrophicis dispositis, parvis, profunde insidentibus, 200–400  $\mu$  diam., soro flavido et peridio conspicue adulto albo membranaceo primum cylindraceo dein irregulariter lacerato praeditis; loculis peridialibus e facie visis irregulariter polygonalibus, 24–30  $\times$  40–48  $\mu$ ; tunica intus extusque tenui, collabescente, interiore minutissime et creberrime verrucosa; aecidiosporis subglobosis vel angulato-ellipsoideis, 22–26  $\times$  26–32  $\mu$ , tunica flavescenti 2–3  $\mu$  cr. prominenter sed minutius verrucoso-tuberculata praeditis.

II. Uredosoris hypophyllis, sparsis, rotundatis, 0.2–0.4 mm. diam., pallide castaneo-brunneis, mox nudis, pulverulentis, epidermide rupta non conspicue cinctis; uredosporis apparenter globosis, 23–25  $\mu$  diam., sed vero in latere inferiore parum depressis; tunica castaneo-brunnea, 2–2.5  $\mu$  cr., in latere depresso circa hilum tenuiore, minute echinulata, verrucis inter se moderate remotis; poris 6–8 vel pluribus, sparsis.

III. Teleutosoris hypophyllis, sparsis vel gregariis, parvis, rotundatis, 0.2–0.4 mm. diam., mox nudis, castaneo-brunneis, dein germinando parum cinerascentibus, compactis, tandem pulvinatis; epidermide rupta non visibili; teleutosporis lineari-cylindraceis, 18–24  $\times$  85–135  $\mu$ , septo ut plurimum visibiliter constrictis; tunica pallide castaneo-brunnea, infra pallidior, 1–2.5  $\mu$  cr., apice ad 10–15  $\mu$  magnopere incrassata et subbulbacea, contra porum cellulae inferioris saepe ad 4  $\mu$  incrassata, levi; pedicello incolori, flexuoso, sporam longitudine aequante vel brevior.

*Steiractinia Rosei* Blake, Huigra, Chimborazo, Ecuador, Aug. 4, 1920, 832.

This species is remarkable because of the extremely long, narrow teliospores. The thickened apex is often somewhat wider than the upper portion of the cell just below, giving the spore a characteristic appearance. The urediniospores are flattened slightly below, and there are 6–10 scattered pores.

433. ***Puccinia subaquila*** Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis, parvis, rotundatis, 0.2–0.4 mm. diam., aurato-brunneis, mox nudis, pulverulentis, epidermide rupta cinctis; uredosporis apparenter globosis sed vero depresso globosis vel ellipsoideis, hilo in uno latere insito praeditis, 18–21  $\mu$  altis, 24–27  $\mu$  latis; pariete pallide cinnamomeo- vel aurato-brunneo, 1.5–2  $\mu$ , minutius crebreque echinulato, poris typice 3–4, aequatorialibus vel parum subaequatorialibus sed in sporis paucis 5, uno ex quorum apice insidente.

III. *Teleutosoris hypophyllis*, sparsis, rotundatis, 0.2–0.5 mm. diam., nigricantibus, mox nudis, compactis, dein subpulvinatis, epidermide rupta inconspicue cinctis; teleutosporis ellipsoideis vel subclavatis, supra rotundatis, infra rotundatis vel contractis, septo vix constrictis, tunica castaneo-brunnea 2–4  $\mu$  cr. apice ad 7–12  $\mu$  magnopere incrassata levi praeditis; pedicello hyalino, firmo, 9  $\mu$  diam., sporam aequante vel dimidio superante sed plerumque brevior.

*Wedelia helianthioides* H.B.K. Choisica, Peru, July 23, 1920, 792; Huigra, Chimborazo, Ecuador, Aug. 4, 1920, 833.

*Wedelia Holwayi* Blake, Cochabamba, Bolivia, March 7, 1920, 376 (type).

This species differs from *P. obrepta* (cf. No. 427) in several details. The teliospores are somewhat shorter and broader, with darker, thicker walls, not germinating. The urediniospores have lighter colored, thinner walls, and the pores are characteristically 3 or 4, equatorial. The two species are clearly related, but differ sufficiently to justify separation. The collections on *Wedelia helianthioides* are referred here provisionally. The teliospores are much the same, but the urediniospores have dark, thick walls, with 3 equatorial pores.

434. ***Puccinia Verbesinae-dentatae*** (Sydow) Jackson & Holway, comb. nov.

*Uredo Verbesinae-dentatae* Sydow, Oesterr. Bot. Zeitschr. 52: 185. 1902.

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*Verbesina adenobasis* Blake, Cuenca, Ecuador, Sept. 15, 1920, 991.

*Verbesina brachypoda* Blake, Cuenca, Ecuador, Sept. 12, 1920, 983.

*Verbesina glabrata* H. & A. Petropolis, Brazil, Oct. 26, 1921, 1250.

*Verbesina* (near *V. glabrata* H. & A.) Ribeirão Pires, São Paulo, Brazil, March 25, 1922, 1678.

*Uredo Verbesinae-dentatae* Syd. was based on material collected in Ecuador, on *V. dentata* H.B.K. The collections listed above from Ecuador agree well with this species. In collection 983 a few telia were found on one leaf. These are pulvinate, light

chestnut brown, germinating at once. The teliospores are long cylindrical 18–24 by 75–120  $\mu$ , usually tapering somewhat at both ends and strongly constricted at the septum. The lower cell is usually longer and narrower than the upper. The wall is golden brown, thin 1–1.5  $\mu$ , not thickened at the apex, except very slightly so at the sides of the pore. The pedicels are colorless, equalling the spore or shorter. The character of the teliospores makes this a very distinct one among *Verbesina* rusts.

The collections from Brazil have somewhat similar urediniospores and are referred here tentatively.

435. ***Puccinia wedeliicola*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, in gregem densum 4–8 aggregatis, maculis decoloratis sed vix hypertrophicis insidentibus, prominulis, punctiformibus, nigrescentibus, globosis vel depresso globosis, 105–135  $\mu$  latis, 90–120  $\mu$  altis; periphysibus fasciculum densum 45–60  $\mu$  altum efformantibus.

I. Aecidiis epiphyllis, plerumque orbiculatim circum pycnidia aggregatis, caeomatiformibus, tarde nudis, pulverulentis, epidermide rupta cinctis, soro albido praeditis, peridio carentibus; aecidiosporis ellipsoideis, saepe subirregularibus, 18–21  $\times$  24–36  $\mu$ , tunica hyalina 2–3  $\mu$  cr. crasse crebreque verrucoso-tuberculata instructis.

II. Uredosoris hypophyllis, sparsis, rotundatis, 0.3–0.5 mm. diam., cinnamomeo-brunneis, mox nudis, pulverulentis, epidermide rupta visibiliter cinctis; uredosporis parum irregulariter globosis vel obovatis, 21–24  $\times$  21–27  $\mu$ ; tunica castaneo-brunnea, 1.5–2  $\mu$ , minute sparsiusque echinulata, poris 2 aequatorialibus praedita.

III. Teleutosoris hypophyllis, sparsis, castaneo-brunneis, dein germinando cinerascentibus, mox nudis, compactis, applanatis, tandem subpulvinatis; epidermide rupta plerumque non visibili; teleutosporis ellipsoideis, oblongis vel clavatis, 16–24  $\times$  42–54  $\mu$ , supra rotundatis, infra pedicellum versus rotundatis vel contractis, leniter medio constrictis; tunica in cellula inferiore aurato-brunneola, 1–1.5  $\mu$  cr., sed in cellula superiore castaneo-brunnea, 1.5–2.5  $\mu$  cr., ad apicem usque 6–9  $\mu$  umbone lato pallideque flavescenti incrassata, levi; pedicello hyalino, sporam aequante vel brevior.

*Wedelia trichostephia* DC. Reserva Florestal, Itatiaya, Rio de Janeiro, Brazil, May 7, 1922, 1822.

This species is quite different from others on *Wedelia* having

thickened apices to the teliospores; on account of the number of pores in the urediniospore wall and the entire absence of a peridium in the aecium.

436. *Uromyces Aspiliae* Jackson & Holway, sp. nov.

O, I. Pycnidiis et aecidiis incognitis.

II. Uredosoris hypophyllis, sparsis vel gregariis, rotundatis, 0.3–0.5 mm. diam., mox nudis, cinnamomeo-brunneis, pulverulentissimis; epidermide rupta inconspicua; uredosporis obovatis vel ellipsoideis vel subtriangularibus,  $21\text{--}24 \times 24\text{--}27 \mu$ ; pariete pallide castaneo-brunneo,  $1.5\text{--}2 \mu$  cr., minute echinulato, verrucis inter se remotis; poris 2, aequatorialibus.

III. Teleutosoris hypophyllis, sparsis vel gregariis, rotundatis, 0.3–0.5 mm. diam., brunneo-nigrescentibus vel castaneo-brunneis, germinando cinerascens, mox nudis, compactis, applanatis, dein pulvinatis; epidermide rupta non visibili; teleutosporis ellipsoideis vel obovatis, saepe parum irregularibus,  $18\text{--}24 \times 27\text{--}36 \mu$ , supra rotundatis vel subobtusis, infra rotundatis vel subangustatis; tunica castaneo-brunnea,  $1.5\text{--}2.5 \mu$  cr., apice umbone parum pallidiore latoque magnopere incrassata ad  $8\text{--}12 \mu$ , levi; pedicello hyalino, flexuoso, duplo sporam superante vel saepius brevior.

*Aspilia phyllostachya* Baker, Petropolis, Rio de Janeiro, Brazil, Nov. 3, 1921, 1271.

437. *UROMYCES BIDENTICOLA* (P. Henn.) Arth. Mycologia 9: 71. 1917.

*Uredo Bidentis* P. Henn. Hedwigia 35: 251. 1896 (Not *U. Bidentis* Lagerh. 1895).

*Puccinia Bidentis* Dietel & Holway; Holway, Bot. Gaz. 24: 32. 1897.

*Uredo bidenticola* P. Henn. Hedwigia 37: 279. 1898.

*Uredo amaniensis* P. Henn. Bot. Jahrb. 38: 106. 1905.

*Uredo bidenticola* Speng. Rev. Argent. de Bot. 1: 134. 1925.

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*Bidens andicola* H.B.K. La Paz, Bolivia, March 24, 1920, 450; Sorata, Bolivia, Apr. 26, 1920, 575.

*Bidens macrantha* Griseb. Cochabamba, Bolivia, March 14, 1920, 410.

*Bidens pilosa* L. San Felipe, Sur Yungas, Bolivia, May 19, 1920, 623; Rio de Janeiro, Brazil, Aug. 12, 1921, 1023.

*Bidens rubifolia* H.B.K. var. Juiz de Fora, Minas Geraes, Brazil, Dec. 17, 1921, 1407.

*Bidens* sp. Petropolis, Rio de Janeiro, Brazil, Nov. 3, 1921, 1276; Campos do Jordão, São Paulo, Brazil, May 1, 1922, 1796; Cuzco, Peru, July 1, 1920, 749.

Several of the collections here reported show primary uredinia; all show uredinia. Whether or not this species should be united with *U. Bidentis* Lagerh. is an open question. It is possible that the species is a mutable one, in which uredinia do not always appear following basidiospore infection. We have preferred to keep the two forms separate for the present, and list as *U. Bidentis* Lagerh. those collections which show a strictly microcyclic condition.

438. *UROMYCES BIDENTIS* Lagerh. Bull. Soc. Myc. Fr. 11: 213. 1895.

*Uromyces densus* Arth. Mycologia 7: 196. 1915.

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*Bidens pilosa* L. Rio de Janeiro, Brazil, Aug. 17, 1921, 1048, Nov. 13, 1921, 1299.

*Bidens* sp. Villa Aspiazu, Sur Yungas, Bolivia, June 1, 1920, 698; Therezopolis, Rio de Janeiro, Brazil, Sept. 28, 1921, 1166.

439. *UROMYCES BLAINVILLEAE* Berk. Jour. Linn. Soc. Bot. 14: 92. 1875.

*Uredo Gaudichaudii* Sydow, Ann. Myc. 1: 21. 1903.

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*Blainvillea dichotoma* (Murr.) Cass. Jardim Botânico, Rio de Janeiro, Brazil, Aug. 11, 1921, 1018; Nictheroy, Rio de Janeiro, Brazil, Aug. 18, 1921, 1054; Copacabana, Rio de Janeiro, Brazil, Sept. 21, 1921, 1131.

440. *Uromyces sphaericus* Jackson & Holway, sp. nov.

O, I. Pycnidii et aecidiis incognitis.

II. Uredosoris amphigenis, sparsis vel gregariis, rotundatis, 0.4–1.0 mm. diam., cinnamomeo-brunneis, mox nudis, pulverulentis; epidermide rupta visibili; uredosporis globosis vel late ellipsoideis, 21–24 × 24–27  $\mu$ ; tunica aurato-brunnea, 2.5–3.5  $\mu$  cr., minute echinulata, verrucis inter se moderate secernatis; poris 4–6, sparsis.

III. Teleutosoris amphigenis, uredosoris conformibus, brunneo-nigrescentibus, pulverulentis; teleutosporis depresso globosis, 20–24  $\mu$  e pedicello ad apicem longis, 24–28  $\mu$  latis; tunica parum opaca, theobromina, 3–5  $\mu$  cr., apice late obscureque umbonata ad 6  $\mu$ , crebre prominenterque verrucoso-echinulata, umbone solo levi; pedicello hyalino, flexuoso, plerumque persistenti, 45  $\mu$  longo vel saepius brevior.

*Perymenium ecuadoricum* Blake, Huigra, Chimborazo, Ecuador, Aug. 3, 1920, 828.

441. UROMYCES WULFFIAE-STENOGLOSSAE Dietel, Ann. Myc. 6: 96. 1908.

*Wulffia maculata* (Ker) DC. Juquery, São Paulo, Brazil, Feb. 14, 1922, 1557; Taquara, Rio de Janeiro, Brazil, Aug. 30, 1921, 1086.

*Wulffia maculata oblongifolia* (DC.) Schulz, Rio de Janeiro, Brazil, Sept. 21, 1921, 1137; Novo Friburgo, Rio de Janeiro, Brazil, Jan. 2, 1922, 1441.

*Wulffia* sp. Tremembé, São Paulo, Brazil, May 30, 1922, 1906.

442. *Uredo irrequisita* Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis, rotundatis, 0.2–0.4 mm. diam., castaneo-brunneis, mox nudis, pulverulentissimis; epidermide fissa plerumque non visibili; uredosporis ellipsoideis, 23–25  $\times$  26–30  $\mu$ ; tunica castaneo-brunnea, 2.5–3  $\mu$  cr., minutissime crebreque verrucoso-echinulata, areis levibus circum supraque poros instructa, poris 2 subaequatorialibus praedita.

*Verbesina dentata* (H. & B.) H.B.K. Riobamba, Ecuador, Aug. 10, 1920, 868.

*Verbesina Hallii* Hieron. Riobamba, Ecuador, Aug. 10, 1920, 866; Quito, Ecuador, Aug. 19, 1920, 920 (type).

*Verbesina Mandonii* Sch. Bip. La Paz, Bolivia, March 24, 1920, 455.

*Verbesina* sp. Urubamba, Urubamba Valley, Cuzco, Peru, July 3, 1920, 758.

In the description given above, the wall thickness is described as it appears when the pores are in face view, that is when the axis of the two pores is vertical as viewed under the microscope. When the spore is slightly turned, so that this axis is oblique,

the wall appears thick above and below, but quite thin at the sides. When the pores are in optical section, that is, when the axis between the pores is horizontal, the wall appears to be thickened on both sides, as well as above and below, leaving four thin spots, two above and two below, between the thickened sides and the thickened apex and base. This gives the spores a very characteristic appearance. No teliospores could be found in any of the collections, all of which appear to be on related hosts.

443. **Uredo Monactidis** Jackson & Holway, sp. nov.

II. Uredosoris amphigenis sed praecipue hypophyllis, sparsis, rotundatis, 0.2–0.5 mm. diam., mox nudis, pallide cinnamomeo-brunneis, pulverulentis; epidermide rupta visibili; uredosporis globosis vel depresso globosis, 23–27  $\mu$  latis, 21–24  $\mu$  altis; tunica cinnamomeo- vel castaneo-brunnea, plerumque supra obscuriore, infra 1–1.5  $\mu$  cr., supra ad 2.5  $\mu$  paulatim incrassata, minute crebreque echinulata; poris parum obscuris, 3–4, aequatorialibus vel leniter subaequatorialibus.

*Monactis subdeltoidea* Rob. Quito, Ecuador, Aug. 28, 1920, 948.

444. **Uredo verbesinicola** Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis, rotundatis, 0.2–0.5 mm. diam., pallide castaneo-brunneis, mox nudis, pulverulentis; epidermide rupta plerumque inconspicua; uredosporis ellipsoideis vel obovatis, 21–24  $\times$  30–36  $\mu$ ; tunica inaequaliter incrassata, castaneo-brunnea, areas duas latas 3–3.5  $\mu$  cr. utrinque efformante itaque annulum aequatorialem irregulariter tenuem pallidiorem 1–1.5  $\mu$  cr. efficiente, minute crebreque echinulata; poris obscuris, 2 pluribusve, in annulo aequatoriali et tenui positis.

*Verbesina Hallii* Hieron. Quito, Ecuador, Aug. 19, 1920, 922A.

A striking species quite different from the *Uredo* of any of the numerous species of *Puccinia* described on this host. The spores are thickened so as to form two caps covering the upper and lower third of the spore, having a broad, irregular, thin band at the equator. The pores are obscure. Two can be seen clearly, but there seem to be more in some spores.



## SPECIES ON CARDUACEAE

## (Tribe Heleneae)

445. *Puccinia indecorata* Jackson & Holway, sp. nov.

O. Pycnidiis non visis, probaliter carentibus.

I. Aecidiis epiphyllis, plerumque singulatim vel in greges 2-3 dispositis, parvis, cupulatis, peridio albo breviter cylindraceo tandem lacerato membranaceo instructis; cellulis peridialibus e facie irregulariter polygonis,  $18-24 \times 30-45 \mu$ ; tunica extus intusque tenui, collabescente, interiore moderate verrucoso-tuberculata; aecidiosporis subglobois vel ellipsoideis,  $21-24 \times 24-28 \mu$ ; tunica hyalina  $1-2.5 \mu$  minute crebreque verrucosa instructis.

III. Teleutosoris amphigenis sed ut plurimum hypophyllis, sparsis, rotundatis, 0.2-0.4 mm. diam., castaneo-brunneis, tandem germinando cinerascentibus, mox nudis, compactis, applanatis, dein pulvinatis, epidermide rupta inconspicuis; teleutosporis ellipsoideis, oblongis vel clavatis,  $20-24 \times 40-65 \mu$ , supra rotundatis vel obtusis, infra rotundatis vel saepius contractis, septo non vel leniter constrictis; tunica aurato-brunnea,  $1-1.5 \mu$  cr., apice ad  $5-9 \mu$  incrassata, levi; pedicello hyalino, sporam aequante vel saepius brevior.

*Tagetes graveolens* Sch. Bip. Sorata, Bolivia, Apr. 12, 1920, 506.

*Tagetes Mandonii* Sch. Bip. Sorata, Bolivia, Apr. 11, 1920, 502 (type).

*Tagetes micrantha* Cav. Sorata, Bolivia, Apr. 29, 1920, 581.

The collection on *Tagetes graveolens* has caulicolous aecia as well as the scattered form on the leaves. The peridial cells are much longer and more slender and the aeciospores somewhat larger. The teliospores are, however, the same as in the collection selected as the type.

No urediniospores could be found in any of the collections, which suggests that the species is an -opsis form.

446. *PUCCINIA TAGETICOLA* Dietel & Holway, Bot. Gaz. 24: 26. 1897.

*Tagetes pusilla* H.B.K. Sorata, Bolivia, Apr. 11, 1920, 500.

A common rust in Central America and the West Indies, which has previously been reported from South America only from Colombia.

447. PUCCINIA POROPHYLLI P. Henn. Hedwigia Beibl. 39: 153. 1900.

*Porophyllum ruderale* (Jacq.) Cass. Poá, São Paulo, Brazil, March 11, 1922, 1625.

This species was originally collected in Venezuela, and is also known from Mexico.

SPECIES ON CARDUACEAE

(Tribe Senecioneae)

448. AECIDIUM LIABI Mayor, Mém. Soc. Neuch. Sci. Nat. 5: 576. 1913.

*Aecidium Liabi* Arth. Bull. Torrey Club 47: 479. 1920.

*Liabum hastifolium* P. & E. Villa Aspiazu, Sur Yungas, Bolivia, June 1, 1920, 694.

Originally described from Colombia, this species is also known from Southern Mexico.

449. *Aecidium quitensis* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, numerosis, in maculis primum flavescentibus dein purpurascentibus laxè aggregatis, prominentibus, punctiformibus, globosis vel ellipsoideis,  $120-180 \times 150-180 \mu$ ; periphysibus non extrusis.

I. Aecidiis hypophyllis, in greges 3-5 mm. diam. crebre gregatim dispositis, saepe circinnatis; peridio pallide flavido, longe, cylindraceo, margine eroso praeditis; cellulis peridialibus e latere visis cubicis vel rectangulis vel subrhomboideis,  $21-28 \times 28-42 \mu$ , contiguus; tunica exteriore  $5-6.5 \mu$  cr., transverse striata, interiore  $5-6.5 \mu$  cr., minute crebreque sed parum prominenter tuberculata; aecidiosporis subglobosis vel irregulariter ellipsoideis,  $22-30 \times 30-40 \mu$ ; tunica incolori, tenui,  $1.5-2 \mu$ , apice ad  $12-18 \mu$  magnopere incrassata, minute crebreque verrucoso-tuberculata.

*Liabum igniarium* (H.B.K.) Less. Quito, Ecuador, Aug. 21, 1920, 932.

Though occurring on the same host as *Aecidium Liabi* Mayor, this species is strikingly different because of the greatly thickened apices of the aeciospore wall.

Holway's field notes indicate that this *Aecidium* may prove to be the aecial stage of *Puccinia oblongula* Jackson & Holway, on *Rynchospora* (See Mycologia 18: 145. 1926).

450. *BAEODROMUS SENECONIS* Sydow, Monog. Ured. 3: 549. 1915.

*Chrysomyxa Senecionis* Lagerh. in herb.

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*Senecio betonicaefolius* DC. Quito, Ecuador, Aug. 23, 1920, 938.

The type of this species was collected by Lagerheim near Chimborazo, Ecuador, on *Senecio* sp. There seems little doubt that our collection is the same. Pycnia accompany the telia in this material. They are epiphyllous, subepidermal, globoid or depressed globoid 100–135  $\mu$  wide by 90–105  $\mu$  high. Ostiolar filaments are not prominent.

451. *CHRYSOPORESA GYNOXIDIS* Lagerh. Ber. Deutsch. Bot. Ges. 9: 345. 1891.

*Gynoxys buxifolia* (H.B.K.) Cass. Quito, Ecuador, Aug. 23, 1920, 944.

*Gynoxys Hallii* Hieron. Quito, Ecuador, Aug. 14, 1920, 890.

*Gynoxys hypomalaca* Blake, Sorata, Bolivia, Apr. 22, 1920, 567.

*Gynoxys* sp. N. of Zaruma, Oro, Ecuador, Sept. 20, 1920, 997.

This very interesting species has apparently been previously known only from Lagerheim's original collections, all made in Ecuador. The collections listed above not only add two new hosts, but extend the range to include Bolivia.

452. *COLEOSPORIUM SENECONIS* (Pers.) Fries, Summa Veg. Scand. 512. 1849.

*Uredo farinosa Senecionis* Pers. Syn. Fung. 218. 1801.

*Uredo Senecionis* Schum. Enum. Pl. Saell. 2: 229. 1803.

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*Senecio adenotrichius* DC. San Felipe, Chile, Sept. 25, 1919, 67.

*Senecio Berterianus* Colla, Papudo, Chile, Sept. 17, 1919, 32.

*Senecio brasiliensis* Less. Therezopolis, Rio de Janeiro, Brazil, Sept. 28, 1921, 1154; Campos do Jordão, São Paulo, Brazil, Apr. 22, 1922, 1753; Curityba, Brazil, June 20, 1922, 1981.

*Senecio collinus* DC. La Paz, Bolivia, March 31, 1920, 487.

*Senecio grandis* Gardn. Itatiaya, Rio de Janeiro, Brazil, May 18, 1922, 1857.

*Senecio hastatus* Bong. Campos do Jordão, São Paulo, Brazil, Apr. 20, 1922, 1742.

*Senecio rudbeckiaefolius* Meyen & Walp. Cochabamba, Bolivia, Feb. 28, 1920, 343.

*Senecio vulgaris* L. Larrain Alcalde, Chile, Oct. 11, 1919, 101.

*Senecio* sp. Papudo, Chile, Sept. 20, 1919, 56; Lota, Chile, Oct. 28, 1919, 144; Between Oruso and Cochabamba, Bolivia, Feb. 23, 1920, 315; Cochabamba, Bolivia, March 5, 1920, 371; Sorata, Bolivia, May 5, 1920, 591; Cuzco, Peru, July 1, 1920, 748; Petropolis, Rio de Janeiro, Brazil, Oct. 16, 1921, 1224; Campos do Jordão, São Paulo, Brazil, Apr. 22, 1922, 1751, 1754; La Falda, Argentina, Apr. 15, 1922, 2030.

453. ***Puccinia condigna*** Jackson & Holway, sp. nov.

O, I. Pycnidiis et aecidiis ignotis.

II. Uredosoris hypophyllis, sparsis, subflavis, parvis, rotundatis, 0.2-0.4 mm. diam., mox nudis, pulverulentis; epidermide rupta plerumque aegre visibili; uredosporis globosis, 24-27  $\mu$  diam., tunica flavescenti tenui 1-1.5  $\mu$  minute crebriusque echinulata praeditis; poris obscuris, 4 pluribusve, adparenter sparsis.

III. Teleutosoris hypophyllis, sparsis, rotundatis, 0.2-0.5 mm. diam., nitide castaneo-brunneis, dein e germinatione cinerascentibus, compactis, applanatis, tandem pulvinatis; epidermide rupta non visibili; teleutosporis oblongis vel ellipsoideis, 24-30  $\times$  54-78  $\mu$ , supra rotundatis, infra rotundatis vel quandoque contractis, plerumque medio visibiliter constrictis; tunica cinnamomeo-brunnea, infra pallidiore, tenui, 1.5-2  $\mu$ , apice ad 4-8  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel saepius brevior.

*Liabum Eggersii* Hieron. Cuenca, Ecuador, Sept. 10, 1920, 969.

454. **PUCCINIA LIABI** Mayor, Mém. Soc. Neuch. Sci. Nat. 5: 539. 1913.

*Liabum Eggersii* Hieron.? Huigra, Chimborazo, Ecuador, Aug. 3, 1920, 820.

*Liabum hastifolium* P. & E. San Felipe, Sur Yungas, Bolivia, May 21, 1920, 636; Hacienda La Florida, Sur Yungas, Bolivia, May 26, 1920, 656.

*Liabum hastatum* (Wedd.) Britton, San Felipe, Sur Yungas, Bolivia, May 19, 1920, 616.

*Liabum* sp. El Chaco, Sur Yungas, Bolivia, May 25, 1920, 647.

These collections, while showing considerable variation, seem best referred to one species for the present. This microcyclic species is known otherwise only from Colombia.

455. ***Puccinia majuscula*** Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, crebre gregariis, in maculis decoloratis insidentibus, prominentibus, punctiformibus, magnis, globosis vel depresso globosis vel ellipsoideis, 180–270  $\mu$  altis, 180–300  $\mu$  latis; periphysibus non prominentibus.

II. Uredosoris primariis epiphyllis, circum pycnidia aggregatis, rotundatis, 0.3–0.6 mm. diam., castaneo-brunneis, tarde nudis, non conspicue pulverulentis, epidermide inflata et poro irregulari aperta diu tectis; uredosoris secundariis primariis conformibus, hypophyllis, sparsis vel gregariis; uredosporis late ellipsoideis, 28–32  $\times$  42–48  $\mu$ ; tunica pallide castaneo-brunnea, 1.5–2.5  $\mu$  cr., valde sparseque echinulata, poris 3 aequatorialibus praedita.

III. Teleutosoris hypophyllis, sparsis vel gregariis, parvis, rotundatis, 0.2–0.4 mm. diam., tardius nudis, pallide castaneo-brunneis sed ob germinationem cinereis, applanatis, tandem pulvinatis; epidermide rupta plerumque non visibili; teleutosporis oblongis vel ellipsoideis vel subclavatis, 24–30  $\times$  60–90  $\mu$ , supra rotundatis vel obtusis, infra rotundatis vel angustatulis, septo plerumque valde constrictis; tunica cinnamomeo-brunnea, 1–1.5  $\mu$  cr., apice non sed in sporis paucis ad 2.5–3  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel brevior.

*Senecio* sp. San Felipe, Sur Yungas, Bolivia, May 19, 1920, 625, May 19, 1920, 627 (type).

The collection first listed above differs from the type in having somewhat smaller urediniospores. These are all secondary. The teliospores are, however, much like the type. The two collections are on different species of *Senecio*.

This is one of a group of three apparently undescribed species having large urediniospores with sparsely echinulate wall markings. They are presumably all brachy-forms, though only the one here described shows primary uredinia.

The species may be separated as follows:

- Teliospores appreciably thickened above . . . . . 456. *P. procerula*.  
 Teliospores essentially unthickened above.  
   Urediniospores with 3 equatorial pores, teliospores 60–  
     90  $\mu$  long. . . . . 455. *P. majuscula*.  
   Urediniospores with 2 equatorial pores, teliospores 45–  
     72  $\mu$  long. . . . . 457. *P. proluviosa*.

456. ***Puccinia procerula*** Jackson & Holway, sp. nov.

II. Uredosoris non visis; uredosporis teleutosoris immixtis, ellipsoideis, 24–30  $\times$  32–45  $\mu$ ; pariete pallide castaneo-brunneo, 1.5–2.5  $\mu$  cr., forte sparseque echinulato; poris 2 vel quandoque 3, aequatorialibus.

III. Teleutosoris hypophyllis, sparsis vel gregariis, primum castaneo-brunneis, dein germinando cinerascens, mox nudis, applanatis, tandem pulvinatis; epidermide rupta non visibili; teleutosporis ellipsoideis vel oblongis vel subclavatis, 22–30  $\times$  48–65  $\mu$ , supra rotundatis, infra rotundatis vel subangustatis, medio leniter constrictis; tunica cinnamomeo-brunnea, tenui, 1–1.5  $\mu$ , supra poros umbone subhyalino ad 6–9  $\mu$  incrassata, levi; pedicello hyalino, sporam aequante vel brevior.

*Senecio pellucidinervis* Sch. Bip. Itatiaya, Rio de Janeiro, Brazil, May 18, 1922, 1865.

This species differs from the preceding in the smaller teliospores and from both the preceding and the following species in having the teliospores with an abrupt umbo over the apical pore. In the germinated spores the umbo disappears, leaving a characteristic thickened collar around the germ pore.

457. ***Puccinia proluviosa*** Jackson & Holway, sp. nov.

II. Uredosoris epiphyllis, in maculis decoloratis singulatim dispositis, bullatis, castaneo-brunneis, 0.3–0.6 mm. diam., tarde nudis, non conspicue pulverulentis, epidermide inflata diu tectis; uredosporis ellipsoideis vel obovatis, 23–26  $\times$  32–38  $\mu$ , tunica pallide castaneo-brunnea 1.5–2  $\mu$  cr. sparse prominenterque echinulata et poris 2 aequatorialibus praeditis.

III. Teleutosoris hypophyllis, sparsis vel gregariis, 0.2–0.4 mm. diam., castaneo-brunneis, dein germinando cinereis, mox nudis, applanatis, tandem pulvinatis; epidermide fissa primo visibili; teleutosporis oblongo-clavatis vel ellipsoideis, 22–28  $\times$  45–72  $\mu$ , supra rotundatis, infra rotundatis vel contractis, septo constrictis; tunica cinnamomeo- vel pallide castaneo-brunnea, in cellula inferiore 1–1.5  $\mu$  cr. sed in cellula superiore leniter paulatimque

ad  $2\text{--}2.5\ \mu$  incrassata, levi; pedicello hyalino, sporam aequante vel saepius brevior.

*Senecio pellucidinervis* Sch. Bip. Campos do Jordão, São Paulo, Brazil, Apr. 24, 1922, 1767.

This species, while obviously related to the two preceding, differs markedly from *P. procerula* in that the teliospores are essentially unthickened at the apex, and from *P. majuscula* in the much smaller, narrower teliospores, as well as in urediniospore pore characters.

Whether or not the epiphyllous uredinia in this species are primary could not be determined. They are badly parasitized in our material and no pycnia could be detected.

458. *UROMYCES WERNERIAE* Lagerh. Bull. Soc. Myc. Fr. 11: 212 1895.

*Werneria nubigenia* H.B.K. Quito, Ecuador, Aug. 19, 1920, 923.

A characteristic microcyclic form that is apparently otherwise known only from the type collection, also from Ecuador.

459. *Uredo Gynoxidis* Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis, parvis, rotundatis,  $0.2\text{--}0.4\ \mu$  diam., pallide castaneo-brunneis, pulverulentis, mox nudis; minutiebus tomento hospitis obscuris; uredosporis ellipsoideis vel obovatis,  $19\text{--}24 \times 28\text{--}34\ \mu$ ; tunica pallide castaneo-brunnea,  $2\text{--}3\ \mu$  cr., quandoque utrinque crassiore, minute echinulata, verrucis inter se moderate sejunctis instructa, poris 2 aequatorialibus praedita.

*Gynoxys Hallii* Hieron. Quito, Ecuador, Aug. 14, 1920, 893.

460. *Uredo senecionicola* Jackson & Holway, sp. nov.

II. Uredosoris hypophyllis, sparsis vel gregariis, pallide castaneo-brunneis, tarde nudis, pulverulentis, epidermide rupta conspicue cinctis; uredosporis ellipsoideis vel obovatis,  $22\text{--}28 \times 28\text{--}32\ \mu$ ; tunica pallide castaneo-brunnea, supra parum obscuriore, tenui,  $1\text{--}1.5\ \mu$ , sparsissime et minutius echinulata, poris 3 aequatorialibus praedita.

*Senecio pimpinellaefolius* H.B.K. Quito, Ecuador, Sept. 2, 1920, 961.

## SPECIES ON CARDUACEAE

## (Tribe Mutisieae)

461. *Aecidium Chuquiraguae* Jackson & Holway, sp. nov.

O. Pycnidiis epiphyllis, numerosis, laxe gregariis, in maculis decoloratis sitis, prominentibus, punctiformibus, globosis, ellipsoideis vel oblongis, 100–135  $\mu$  latis, 120–180  $\mu$  altis; periphysibus fasciculum laxum 45  $\mu$  altum efformantibus.

I. Aecidiis hypophyllis, in areis 1–2 cm. diam. saepe confluentibus laxe gregatim insidentibus, peridio flavido conspicue adulto firmo breviter cylindraceo tandem lacerato instructis; cellulis peridialibus e latere visis rhomboideis, 14–16  $\times$  30–36  $\mu$ , subforte imbricatis; tunica exteriori 2–3.5  $\mu$  cr., levi, interiore 2–3  $\mu$ , crebre verrucoso-rugosa; aecidiosporis subglobosis vel ellipsoideis, 22–26  $\times$  28–36  $\mu$ , tunica hyalina 1.5–2  $\mu$  una fine ad 7–15  $\mu$  magnopere incrassata crebre et parum prominenter verrucosa praeditis.

*Chuquiragua* sp. Campos do Jordão, São Paulo, Brazil, Apr. 20, 1922, 1743.

No other *Aecidium* seems to have been reported on this host genus. The species appears to be quite characteristic, on account of the habit, and also because of the extreme thickening of the aeciospore wall at one end of the spore.

## 462. DIDYMOPSIS CHUQUIRAGUAE Dietel, Hedwigia 38: 255. 1899.

*Chuquiragua glabra multiflora* Baker, Therezopolis, Rio de Janeiro, Brazil, Oct. 15, 1921, 1218.

This very characteristic species was based on two collections on *Chuquiragua tomentosa* Baker, made by Ule, in Santa Catharina and Tijuca, Brazil. It seems not to have been otherwise reported.

## 463. PUCCINIA CRASSICUTIS Sydow, Monog. Ured. 1: 125. 1902.

*Mutisia viciaefolia* Cav. Cochabamba, Bolivia, Feb. 28, 1920, 344; La Paz, Bolivia, March 20, 1920, 440; Cuzco, Peru, June 30, 1920, 745.

The collections listed above seem to fit this species well. It was originally described from Bolivia on *Mutisia Clematis* L., and differs from others on this host genus in having the teliospore wall verrucose.



**464. *Puccinia defecta* Jackson & Holway, sp. nov.**

O. Pycnidiis epiphyllis, paucis in omni grege insidentibus, areas decoloratas et subhypertrophicas occupantibus, punctiformibus, prominentibus, primo flavidis, demum nigricantibus, globosis vel depressa globosis, 90–120  $\mu$  altis, 105–150  $\mu$  latis; periphysibus non extrusis.

III. Teleutosoris epiphyllis, gregariis et saepe in gregem 1–1.5 mm. diam. confluentibus, pycnidia circumdantibus, annulum perfectum saepe efformantibus, mox nudis, compactis, applanatis, tandem pulvinatis, castaneo-brunneis, dein germinando cinerascens, epidermide rupta in soris maturis non visibili; teleutosporis oblongis vel cylindraceis, 15–24  $\times$  60–105  $\mu$ , supra rotundatis vel obtusis sed infra plerumque truncatis, medio valde constrictis; tunica aurato-brunnea, tenui, 1–1.5  $\mu$ , ad apicem usque 3–5  $\mu$  incrassata, levi; pedicello hyalino, primum lato, 15  $\mu$ , mox collabescente et flexuoso, sporam dimidio superante vel brevior.

*Jungia rugosa* Less. Cuenca, Aguay, Ecuador, Sept. 15, 1920, 994.

This very characteristic microcyclic species is entirely epiphyllous. The pycnia are surrounded by the telia, often in a complete circle. It is quite different from *P. Jungiae* P. Henn.

**465. *Puccinia subita* Jackson & Holway, sp. nov.**

O. Pycnidiis epiphyllis, laxe gregariis, maculis decoloratis insidentibus, applanatis, 120–135  $\mu$  altis, 240–270  $\mu$  latis, poro aperitis, aperiphysatis.

II. Uredosoris amphigenis, sparsis vel gregariis, cinnamomeo-brunneis, parvis, rotundatis, 0.2–0.4 mm. diam., tarde nudis, pulverulentis, epidermide rupta cinctis; uredosporis globosis, 29–31  $\mu$  diam., vel quandoque ellipsoideis, 27–30  $\times$  30–32  $\mu$ ; tunica aurato-brunnea, 2–3  $\mu$  cr., crebre tenuiter verrucosa, poris 6 sparsis praedita.

III. Teleutosoris amphigenis, sparsis vel gregariis, parvis, rotundatis, 0.2–0.4 mm. diam., castaneo-brunneis, dein ob germinationem cinereis, compactis, applanatis, tandem subpulvinatis, epidermide rupta non visibili; teleutosporis ellipsoideis vel oblongis vel clavatis, 26–30  $\times$  48–75  $\mu$ , supra rotundatis, infra rotundatis vel attenuatis, septo leniter vel non constrictis; pariete pallide castaneo-brunneo, tenui, 1–2  $\mu$ , apice ad 5–7  $\mu$  incrassato, levi, fine incrassata sola recte rugosa; pedicello hyalino, flexuoso, sporam duplo superante vel brevior.

*Mutisia sagittifolia* Blake, Quito, Ecuador, Aug. 23, 1920, 941.

A very different species from *P. Mutisiae* Lag., and separable from *P. mutisiicola* Speg. by the greatly thickened apices of the teliospores.

SPECIES ON CARDUACEAE

(Tribe Cichorieae)

466. PUCCINIA CICHORII (DC.) Bellynck; Kickx. Fl. Crypt. Fland. 2: 65. 1867.

*Uredo Cichorii* DC. Fl. Fr. 6: 74. 1815.

*Caeoma Cichorii* Link, in Willd. Sp. Pl. 6: 18. 1825.

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*Cichorium Intybus* L. Panimávida, Chile, Dec. 12, 1919, 220;  
Emsenada, Lago Llanquihue, Chile, Nov. 28, 1919, 189;  
Valdivia, Chile, Nov. 13, 1919, 173.

467. PUCCINIA HIERACII (Schum.) Mart. Fl. Mosq. 226. 1817.

*Uredo Hieracii* Schum. Enum. Pl. Saell. 2: 233. 1803.

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*Hieracium pazense* Blake, La Paz, Bolivia, March 19, 1920, 425.

*Hieracium* sp. La Paz, Bolivia, March 26, 1920, 467.

The four species on Cichorieae might perhaps all be included under the above name. For the purposes of this account, however, it has seemed desirable to list them separately.

468. PUCCINIA HYPOCHAERIDIS Oud. Nederl. Kruidk. Arch. II 1: 175. 1872.

*Hypochaeris glabra* L. Vina del Mar, Chile, Sept. 5, 1919, 4;  
Papudo, Chile, Sept. 17, 1920, 33; Larrain Alcaldia, Chile,  
Oct. 11, 1919, 104; Zapallar, Chile, Feb. 1, 1920, 311.

*Hypochaeris radicata* L. Panimávida, Chile, Dec. 14, 1919, 229.

469. PUCCINIA TARAXICI (Rebent.) Plowr. Brit. Ured. 186. 1889.

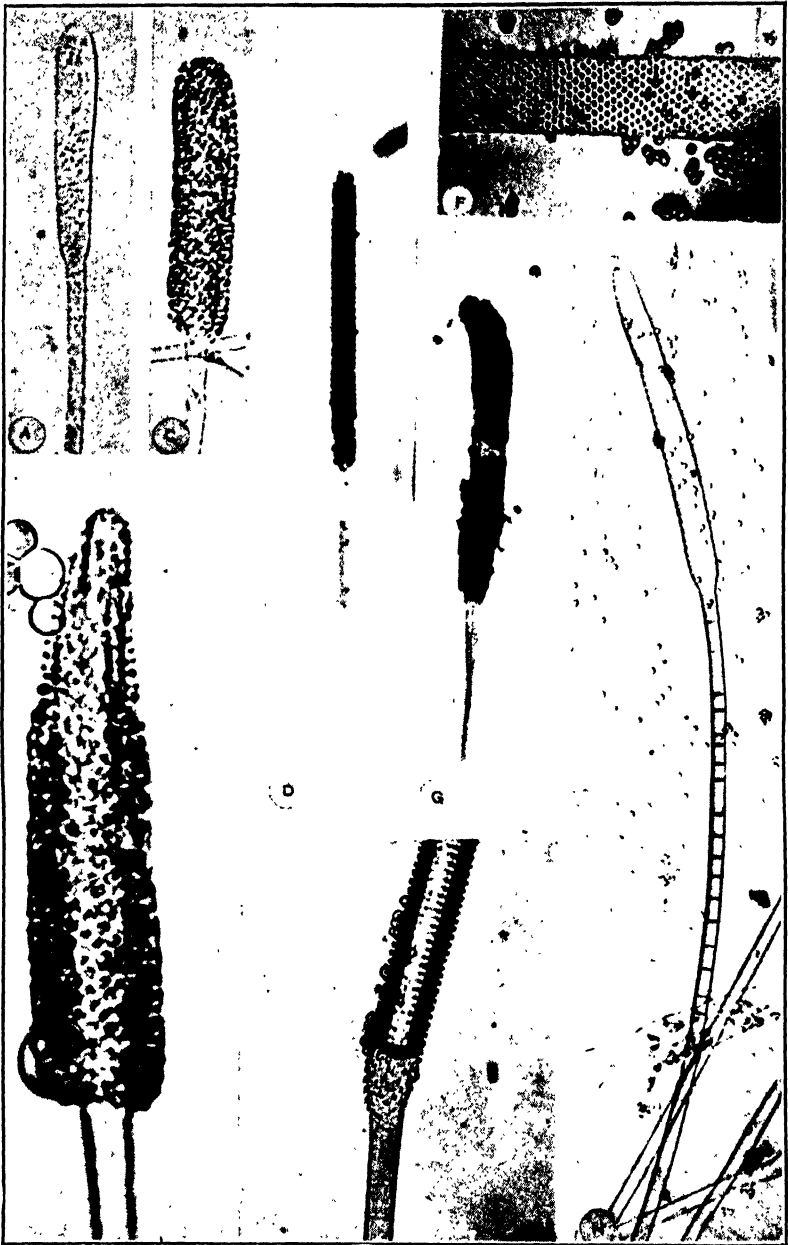
*Puccinia Phaseoli Taraxici* Rebent. Prodr. Fl. Neom. 356.  
1804.

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*Leontodon Taraxacum* L. Puente Alto, near Santiago, Chile,  
Oct. 3, 1919, 85.

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MYCOTYPHA MICROSPORA

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## MYCOTYPHA MICROSPORA, A NEW GENUS OF THE MUCORACEAE

E. ALINE FENNER

(WITH PLATES 2 AND 3 AND 1 TEXT FIGURE)

### INTRODUCTION

The fungus described in this paper was found growing as a contamination on a plate culture of a pathogenic organism of the orange. Because of the unknown source of the fungus it has been necessary for the writer to limit her observations to its growth and development on artificial media and while perhaps of no interest as a pathological problem, the unusual nature of the fungus and its many variations make it an interesting object for study from the standpoint of mycology.

After making a thorough study of this fungus and searching the literature for an organism either identical with or similar to it, the writer has come to the conclusion that it represents a new genus of the Mucoraceae, belonging to the tribe Cephalideae, according to the classification followed by Gäumann and Dodge (9). This group includes *Choanephora*, *Cunninghamella*, *Blakeslea*, *Syncephalastrum*, *Syncephalis* and *Piptocephalis*, genera which are characterized by the conidial fructifications rather than the sporangial type; however, the latter are sometimes present also. Although it is customary to place a fungus with the Fungi Imperfecti until the perfect stage has been found, certain characteristics of the fungus under discussion show such a marked resemblance to the genera of the Mucoraceae, that the writer feels justified in placing it in this family. Notwithstanding the fact that zygospores have never been observed, an effort has been

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made in this paper to point out certain characteristics which are common to members of the Cephalideae and to the fungus herein described.

#### DESCRIPTION OF THE FUNGUS

One of the characters common to genera of the Cephalideae and to the fungus under consideration is the nature of the thallus. The vegetative hyphae spread over the surface of the substratum forming a thallus that resembles those found among species of the Mucoraceae. It is much branched, contains a dense granular protoplasm and frequently many vacuoles. There is a lack of uniformity in the diameter of the mycelium (PLATE 3, FIG. E) and at times the main tubes are swollen and constricted, generally where the secondary branches are attached. These large trunks give rise to numerous small branches that usually extend nearly parallel to the main hyphae. There is a marked difference in diameter at the tips of the hyphal branches which are finely attenuate as compared with that at their origin (FIG. 1). The contents of the tips of these hyphae appear to be more homogeneous than the dense granular protoplasm of the main trunks. The thallus is coenocytic during the period of growth but septation occurs at maturity about coincident with the time of sporulation. The septa are irregularly disposed, frequently occurring in close proximity to the origin of a branch or often separating the younger growth from the older vacuolated portions.

The fructifications originate as long slender filaments arising from the vegetative hyphae. The extremities of these filaments are at first filled with a homogeneous protoplasm that becomes coarsely granular and assumes a reticulate appearance. These filaments become dilated to form capitella (PLATE 2, FIG. A), the shape of which is suggestive of miniature cat-tails (PLATE 2, FIGS. C AND D). The sterigmata appear as slight swellings on the capitellum from which conidia bud (PLATE 2, FIG. B), and enlarge until they entirely cover the hollow cylindrical head. The tiny sterigmata appear to be arranged in a flat right hand spiral around the capitellum, although other more prominent spirals of a very high pitch may also be traced both clockwise and counterclockwise. The sterigmata on the flat primary spiral

are so spaced that those of one coil alternate with the ones on the coil above and below it. On a naked collapsed head from which the spores have abscised, the sterigmata appear to be arranged in diagonal rows as illustrated in (PLATE 2, FIG. F). The fertile heads usually appear from 24 to 48 hours after the spores



FIG. 1. A thallus of the fungus, *Mycotypha microspora* showing the main trunks and the finely attenuate tips ( $\times 130$ ).

are sown, the length of time depending on the temperature, moisture and nature of the substratum. Tiny water drops are formed during the growing period and adhere to the aerial mycelium for several days after the heads are formed. The obser-



vations regarding color were made when the fungus was grown on Leonian's agar, potato dextrose, and other rich media but the color varies somewhat, depending on the nature of the substratum. The fructifications are at first white, sometimes showing a pinkish iridescence. They become darker at maturity gradually changing from a pale violet gray to a dusky slate gray (14). In extreme old age the colonies become a deep brown color. The fructifications grow compactly together (PLATE 3, FIG. A), and although not rigid they generally stand erect. As the fungus is extremely heliotropic, the conidiophores tend to incline toward the source of the illumination (PLATE 3, FIG. C).

The capitella vary in length from  $20\ \mu$  to over  $500\ \mu$  but the majority measure about  $200\ \mu \times 17\ \mu$  to  $20\ \mu$  with the spores removed. The very small heads may be considered more of an aborted form resulting from a deficient medium. The conidiophores, frequently bearing lateral branches, are several times as long as the cylindrical heads. They are non-septate in a fresh culture but usually 3 to 4 days after germination numerous septa are formed at intervals of 8 to  $10\ \mu$  or even less (PLATE 2, FIG. H). This septation is characteristic of *Thummocephalis* (1) and its near relatives. The conidiophores at first are hyaline but become yellowish with age.

The conidia are caducous at maturity leaving the hollow cylindrical head exposed. Under low power the naked capitellum appears to be marked with many areolations or orifices but proper focusing after the spores have fallen off reveals numerous protuberances bearing scars where the sterigmata were attached (PLATE 2, FIG. E). In shape, the conidia vary from ovoid to spherical and range in color from hyaline to a pale bluish-green. The sterigmata generally adhere to the conidia as small hyaline beak-like appendages after the conidia have dropped from the head. Under high power either a nucleus or a vacuole is visible but the spores are so minute that no definite statement can be made in this regard. No outer wall is present so far as the writer can ascertain, although some authors have disagreed on this point in reference to other similar conidia-bearing fungi, Van Tieghem (17) and others contending that the structures borne on the heads are one-spored sporangia rather than true conidia.

The spores vary from 2 to 4  $\mu$  in diameter and average about 2.5  $\mu$ . The possible error resulting from the minuteness of the spores and their motion in the mounting fluid was compensated for by the fact that all measurements were made under the same conditions. Germination takes place on culture media a few hours after the conidia are sown, the length of the period depending on the conditions of temperature, moisture and nutrition. They do not germinate in water. The conidia enlarge considerably before germination, and although one or two germ tubes may be formed, one has been observed in most instances.

#### VARIABILITY

Like many other members of the Mucoraceae, the fungus under consideration shows interesting variations in culture. The organism has been grown on a large variety of artificial media but the description and measurements given in this paper are confined to the monosporous cultures grown on Leonian's agar, as experience with various other fungi has shown that their growth and development may be regarded as normal on this substratum. The organism grows rapidly and luxuriantly on rich nutrient media such as potato dextrose and carrot agars, but practically no growth occurs on media of a low pH value. The fungus behaves in an interesting manner when grown on potato dextrose or carrot agar, particularly during the summer months or at a high artificial temperature. The growth is unusually luxuriant at a temperature of 35° C., whereas practically no growth results when cultures are kept at a temperature of about 10° C. When grown under very favorable conditions, secondary heads are sometimes formed directly on the capitellum (PLATE 2, FIG. G) not unlike the ramuli which develop on the capitate vesicle of *Choanephora cucurbitarum* (4). Secondary heads have also been observed by the writer in *Cunninghamella*. Frequently these secondary fructifications are exact miniatures of the large primary head but in most instances they are nearly spherical. When spores from one of these tiny heads are sown, normal individuals are produced. The spherical type of head has also been observed when a weak medium is used as the substratum or in an old culture after the nutritive elements have been exhausted.

There are many gradations in size and shape between the large cylindrical and the small spherical type of fructifications.

Self penetration or "Durchwachsungen" is one of the modifications noted when the fungus is grown on a rich medium and at a high temperature (PLATE 3, FIG. D). Certain vegetative hyphae enter those devoid of protoplasm and take the place of dead portions of the hyphae. This condition has been mentioned frequently in the literature. Duggar and Stewart (8) reported self penetration in *Rhizoctonia*, Dodge (7) has observed it in *Ascobolus magnificus* and many others have referred to its occurrence in various fungi.

One of the peculiarities of this fungus is the typical development of its fructifications at night. According to Cunningham (4) *Choanephora* behaves in a similar manner. Möller (12) and Palm and Jochems (13) have also observed that *Choanephora* forms its fertile heads in darkness or in the early hours of the morning. The writer has found it impossible to study spore formation during the daytime when the fungus is grown under normal conditions of light and dark. However, when the rhythm is interrupted, heads in various stages of development may be observed. This was done by subjecting plate cultures of the organism to artificial light during the night for several weeks. Other plates were kept in constant darkness for the same period of time. Both sets of cultures produced fertile heads, those in the light seeming to be more perfectly developed even than those in the dark. Since there was a possibility that diurnal changes in temperature rather than the alternation of light and dark might influence spore formation, the normal changes of temperature were duplicated as nearly as possible in the laboratory, and observations made in reference to the development of the aerial filaments. In this experiment little if any significance could be attached to temperature changes as contributing factors in spore formation.

The organism's response to light has been previously mentioned. When a Petri dish culture is turned away from the source of the illumination, the aerial filaments turn back again after a period of time varying from a few hours to 48 hours. If the culture remains for a long time in one position in reference to the source

of light, concentric zones of growth (PLATE 3, FIG. B) are formed, probably resulting from the periodic dropping of spores during the day. Plate cultures of the fungus which were kept in complete darkness for several weeks show that the conidia are not deciduous under these conditions. Weimer (19) reports the influence of light upon the direction in which the spores of *Pleuroge* are discharged.

#### SPHERICAL BODIES

Under certain conditions the fungus produces interesting spherical bodies, the average size being about  $20\ \mu$  in diameter. Although considerable study has been made of these bodies, their true nature can not be wholly explained and the writer can only offer an opinion as to their origin and function, based on the facts here recorded. These spherical structures are easily overlooked as they are usually formed below the surface of the substratum. They were first observed in an old culture and at that time they were thought to be the result of degeneration. Further study has shown, however, that they develop when the culture is comparatively young and have been observed clustered near the center of a young thallus before the fructifications are formed. They have been found in great abundance on Leonian's agar, and a medium which is semi-liquid or one that contains a large amount of sugar seems to encourage their development. So far as the writer can ascertain, spherical structures containing a dense vacuolate protoplasm are usually formed apically on the hyphae. These bodies closely resemble the azygospores frequently found in one strain of a heterothallic fungus in the absence of the other strain. Occasionally one of these bodies will be noticed with a club-like structure attached (PLATE 3, FIG. G), not unlike the oogonium with the accompanying antheridium characteristic of the *Saprolegnia*. Further study of these spherical structures revealed a number of similar bodies with translucent watery contents and thin outer membrane, clustered around and appearing to cling to the primary organ (PLATE 3, FIG. E). These are suggestive of a group of adherent bubbles with no apparent means of attachment, the secondary spheres breaking away from the mother sphere after a time. Observations indicate that a process of budding takes place similar to that occurring in yeast

and many other fungi. Gäumann and Dodge (9) report that in certain families of the Zygomycetes the mycelium sometimes breaks up into oidia and hyphal bodies from which sprout cells later develop. Heald (10) mentions that under abnormal conditions the hyphae of some of the Zygomycetes divide into cells similar to yeast cells in their behavior. In at least some of these spherical bodies, a differentiation of protoplasm occurs forming a spherical endogenous body with a thick outer wall. These bodies have been observed in the act of breaking away from the encompassing wall (PLATE 3, FIG. F) and frequently have been seen to germinate. These structures have somewhat the appearance of the monosporangium type of fructification found in certain species of Mucoraceae and behave in much the same manner as the sporangiospore when it leaves the monosporangium. Other bodies which are frequently arranged in chains have been found in dried plate cultures and considered as true chlamydospores.

#### TAXONOMIC DISCUSSION

This fungus is one of the few interesting fungi that has affinities with both the Hyphomycetes and the Mucorales and it is difficult to assign it to its exact taxonomic position. In the absence of zygospores the writer considered placing the fungus under discussion among the Hyphomycetes in the neighborhood of *Rhopalomyces* and *Oedocephalum*, particularly the latter, one species of which Vuillemin (18) proved to be connected with *Aleuria asterigma*, of the *Peziza* group. Thaxter (15) has reported finding several species of small *Peziza* in cultures of *Oedocephalum* which strengthens Vuillemin's hypothesis of a connection between these fungi. Brefeld (3) also established a relationship between one of the Basidiomycetes, *Polyporus annosus* and an *Oedocephalum*-like fungus. *Cunninghamella echinulata* was first described by Thaxter (16) under the name of *Oedocephalum echinulata* and the same author, in his study of *Choanephora cucurbitarum*, found it had previously been described under the name of *Rhopalomyces cucurbitarum* Berk. & Rav., a near relative of *Oedocephalum*. Boedijn (2) also claims that *Rhopalomyces elegans* Corda is a true Zygomycete regardless of the absence of the sexual stage.

Cunningham (5) and others maintain that the type of fructi-

fication depends on nutrition and environmental factors. With this in mind numerous fruitless attempts have been made to produce zygospores in culture by growing the fungus on a large variety of substrata and under various conditions of temperature, moisture and light. The behavior of the organism at times leads the writer to believe that the fungus represents one strain of a heterothallic species. When grown on beef agar the twisting of certain mycelial filaments resembles to a marked degree the manner of coiling found in the copulation branches of some species of the Mucoraceae, such as *Syncephalis*, during the process of zygospore formation.

Both Wolf (20) and Dastur (6) have pointed out in the case of *Choanephora*, that zygospores are produced in artificial cultures only when the cultures are made directly from the fungus growing on the host plant. In view of the apparent affinity between *Choanephora* and the fungus under consideration, it is possible that the latter possesses this same characteristic.

As a result of experimentation with several hundred different fungi as hosts, Matruchot (11) concluded that spores of *Piptocephalis* will germinate only in the presence of some species of the Mucoraceae. It was as a result of these experiments that he claimed that *Choanephora* and *Cunninghamella* belong to this group. The writer has tried this experiment using the fungus herein described as host. When grown with the latter on plates of cornmeal agar, the spores of *Piptocephalis* germinate and the hyphae of *Piptocephalis* appear to be attached to those of the host and to coil around them. If Matruchot is correct in his deductions, one would be justified in believing the fungus described here to be a member of the Mucoraceae. Regardless of any taxonomic value, however, this proves an interesting experiment.

From all the information gained in the study of the fungus described in this paper, the writer has come to the conclusion that it belongs in the tribe Cephalideae of the Mucoraceae, because of the Mucoraceous type of thallus, its coenocytic nature and a number of other attributes which are characteristic of this group of fungi.

The name *Mycotypha microspora* is suggested for the fungus

because of the cat-tail-like fructifications and the extremely minute spores.

The writer wishes to express her indebtedness to Dr. C. H. Kauffman, Dr. H. M. Fitzpatrick, Dr. Roland Thaxter and others for examining the fungus and for helpful suggestions, and to Miss Vera K. Charles, Associate Pathologist, Bureau of Plant Industry, for carefully reading and criticizing the manuscript.

### ***Mycotypha* gen. nov.**

Hyphae steriles primo continuae, in aetate septatae. Hyphae fertiles plerumque erectae, conidiophoris longis gracilibus capitella fertilia ferentibus. Conidiophora interdum ramosa, primo continua, deinde multiseptata. Capitella cylindrica, conidia solitaria communiter in brevis sterigmatibus ferentia.

### ***Mycotypha microspora* sp. nov.**

Mycelium sterile praecipuis truncis hyalinis, dense granulosum, irregulariter ramosum, apicibus minute attenuatis, primo continuis, in maturitate septatis. Hyphae fertiles gregariae, fere erectae, seu plerumque semiprostratae. Conidiophora longa, gracilia, primo continua, deinde septata, in culturis juvenilibus hyalina, in aetate luteola-fusca. Capitella cylindrica, in longitudine variabilia, sine conidiis plus minusve  $200-300\ \mu \times 17-20\ \mu$ , conidiis primo albis, deinde obscuris cineris-subcaeruliis, sterigmatibus in spira plana institutis, unae spirae aliis supra et infra alternantibus, in seriebus diagonalibus in vescicula nuda collapsa, minutis, inconspicuis, saepe ad conidia adhaerescantibus. Conidia multa, minuta, caduca, hyalina-viridicaerulescentia, ovoidea-globosa,  $2-4\ \mu$  diam. plerumque  $2.5\ \mu$ .

Pseudogemmae plerumque praesentes, in agaro submersae, in medio semi-liquido seu saccharino magis copiosae, gemmiparae et ab cellula primaria derumpentes, primo translucidae, plerumque chlamydosporas simulates.

Pseudogemmae sometimes present, submerged in agar, occurring more abundantly on semi-liquid or saccharine media, budding and breaking away from primary cell, translucent at first, sometimes appearing to function as resting spores.

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## EXPLANATION OF PLATES

## PLATE 2

Fig. A, An early stage in the formation of a fruiting body, showing the dilated extremity of the filament and the dense granular protoplasm.  $\times 300$ ;  
 B, A head in the process of development, partially covered with conidia.



Some sterigmata are noticeable. A group of spherical bodies is also present.  $\times 500$ ; *C*, A more advanced stage in the development of the capitellum.  $\times 130$ ; *D*, A mature cat-tail-like head, with some of the conidia detached; *E*, A portion of a naked capitellum showing the sterigmata from which the spores have fallen; *F*, Portion of a naked collapsed capitellum from which the conidia have fallen, showing the spiral arrangement of the sterigmata as diagonal rows. A few conidia with sterigmata adhering are also shown; *G*, A capitellum showing secondary heads which frequently develop when the organism is grown on a very rich medium; *H*, Septation of the conidiophore which occurs after maturity is reached. A capitellum with spores detached is also shown.  $\times 230$ .

### PLATE 3

Fig. *A*, Colonies of the fungus showing the compact growth. Natural size; *B*, A section of a plate culture showing zoning. Natural size; *C*, A portion of a plate culture showing the heliotropic nature of the fungus. Natural size; *D*, Self-penetration or "Durchwachsungen"; *E*, Two spherical bodies surrounded by a number of pseudogemmae. The lack of uniformity in the diameter of the hyphae is also shown.  $\times 330$ ; *F*, Endogenous portion of a spherical body, breaking away from encompassing wall; *G*, One type of spherical body with club-like structure attached, frequently found submerged in agar.



G  
MYCOTYPHA MICROSPORA



# PHOMA CONIDIOGENA ON BOX

MARJORIE E. SWIFT

(WITH PLATE 4 AND 2 TEXT FIGURES)

A distinctive leaf tip blight of two bushes of *Buxus sempervirens* var. *angustifolia* Linn. was noted in the late summer of 1930 in The New York Botanical Garden boxwood collection. The leaves of the current year's growth, as well as older ones, were affected. The necrotic area was always at the extreme tip of the leaf and contrasted markedly with the healthy portion because of its ashy gray color and very thin texture. It was separated from the green portion of the leaf by a very narrow dark band made up of alternating gray, black and brown lines (PLATE 4, A). Small dark brown to black ostiolate pycnidia were scattered irregularly on both surfaces of the dead area (PLATE 4, B, C).

In October of the same year the trouble was observed in another planting considerably removed from the first. The only variety affected was again *Buxus sempervirens* var. *angustifolia*. Spores from these plants were still viable in February, 1931, after having weathered winter conditions.

The bushes on which the fungus was first seen again furnished abundant material in the spring of 1931, but only on old leaves. Not until September was the new growth found affected.

The fungus is not confined to the leaves, but was also found in defoliated dying twigs. Fruit bodies were not observed in these instances, but the fungus was isolated from internal tissue.

## THE FUNGUS

Measurements of pycnidia and spores from leaves, before culturing, led to classification of the fungus as *Phyllosticta Auerswaldii*,<sup>1</sup> which was described as causing a white spot particularly at the tips of *Buxus sempervirens* leaves, with fruit bodies

<sup>1</sup> Allescher, Andreas. Fungi imperfecti. In Rabenhorst's Krypt.-Fl. 16: 25. 1901.

scattered on the upper surface. The boxwood fungus met this description in every way except that pycnidia occurred on both surfaces of the leaf. Culture work, however, made necessary a different classification.

Isolations were made both from pieces of affected tissue surface-sterilized with mercuric bichloride and from single pycnosporos. Within twenty-four hours pycnidia like those seen on the leaves were beginning to form upon and within the agar (corn meal) in markedly radiating lines from the center of the darkening, greenish brown growth. Later rosy masses of spores oozed from the conspicuous ostioles in moist droplets, or in cirri under drier conditions (PLATE 4, G). After the third day dusky aerial hyphae became more abundant, and a new kind of spore was observed in chains here and there about the periphery of the colony. They were of the dark muriform *Alternaria* type and were thought at first to represent a contaminant, although their relation to the rest of the culture did not suggest such a conclusion (PLATE 4, H, I). To determine whether or not they belonged to the boxwood fungus they were picked off and grown singly. The resulting cultures were identical with those obtained from the single pycnosporos. Repeated monospore cultures of both the *Alternaria* and the *Phoma* spores have since been made and all cultures (except a "mutant" to be described later) have produced both types of spores. Examination of the affected leaf tips for any *Alternaria* spores showed only occasional chains of short rough brown cells in the diseased portions. However, when mycelium from pure cultures was placed on moist box leaves in test-tubes where the air was kept saturated, both types of spores were produced in abundance.

Examination of the literature has yielded no description of such a dimorphic fungus on boxwood. Schnegg<sup>2</sup> in 1915 described a similar fungus common in brewery liquids, and named it *Phoma conidiogena*. He studied in detail pycnidium formation, and considered the *Alternaria* spores, which were much less abundant in his cultures, merely as resting cells ("Dauerzellen").

<sup>2</sup> Schnegg, Hans. Zur Entwicklungsgeschichte und Biologie der Pycniden, sowie der Schlingenmycelien und Hyphenknäuel. Centralbl. Bakt., Parasit. Infekt. 43: 326-364. 1915.

The boxwood fungus is, without question, a strain of *Phoma conidiogena*.

Brooks & Searle <sup>3</sup> in 1921 described another strain of the fungus as *Phoma alternariaceum*, isolated from rotting tomato fruits. They interpreted the dark catenulate bodies as true *Alternaria* spores. Chodat <sup>4</sup> studied their fungus with particular reference to mutations, but refers to the dark conidia as "hypnocysts"

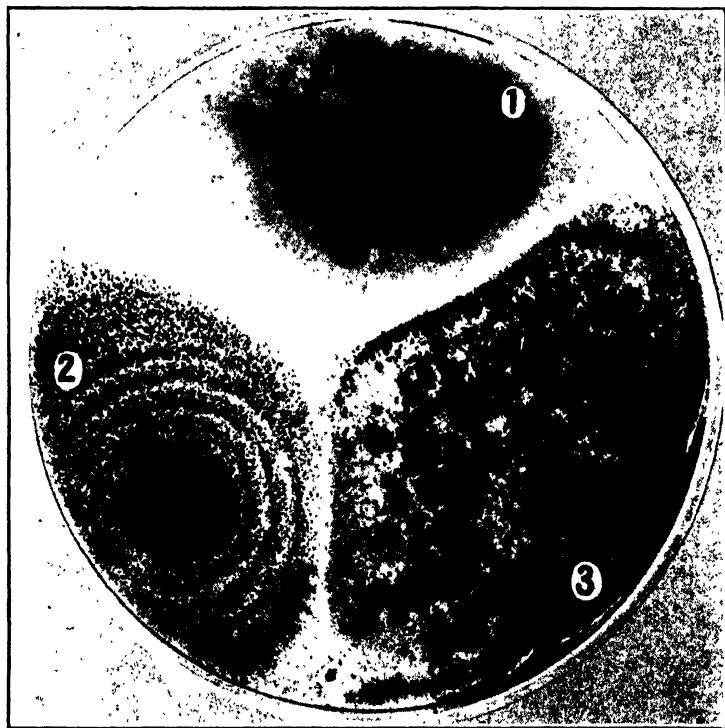


FIG. 1. Three strains of *Phoma conidiogena* one month old—1, from tomato fruit (Brooks & Searle's *P. alternariaceum*); 2, from cellar air (Benham); and 3, from boxwood.

and not true conidia, on the ground that they are found in the internal hyphae as well as aeriaily and are merely nutritive. Our cultures show only thickened dark mycelial cells in the sub-

<sup>3</sup> Brooks, F. T. & Searle, G. O. An investigation of some tomato diseases. Trans. Brit. Myc. Soc. 7: 173-197. 1921.

<sup>4</sup> Chodat, Fernand. Recherches expérimentales sur la mutation chez les champignons. Bull. Soc. Bot. Genève, II, 18: 41-144. 1926.

merged hyphae. In none of Chodat's strains, however, did he describe the hypnocysts in such numbers as they occur in the boxwood fungus. His stock culture produced hypnocysts in a little more than a month, and his most fertile mutant in fifteen days. The boxwood fungus produces them in three or four days in abundance (PLATE 4, H, I).

A culture of the Brooks and Searle *Phoma alternariaceum* was obtained from the Centraalbureau voor Schimmelcultures at Baarn, Holland, for the purpose of comparison with the present form. No spores of any kind, however, have been produced, although the fungus has been grown on dextrose, potato dextrose, Czapek, prune, malt and corn meal agar, on boxwood leaves, potato tubers and tomato fruits (FIG. 1). Nothing but brown thick-walled mycelial enlargements have appeared.

A similar *Phoma* has been isolated by Benham<sup>5</sup> from cellar air in connection with asthma investigations at the Laboratory of Medical Mycology, College of Physicians and Surgeons, Columbia University. Her paper presents in detail the taxonomic features of this type of fungus.

These three strains are shown in figure 1 after a month's growth on a corn meal agar plate. Whether such differences as are evident here in gross culture should constitute species distinctions is questionable, since they are not more than exist between mutant strains.

#### CULTURE CHARACTERISTICS OF THE BOXWOOD STRAIN

*On Corn Meal Agar:* Colony spreading, at first hyaline and submerged, becoming dusky greenish brown with shadowy aerial hyphae particularly at the periphery; in age completely black with tufts of aerial hyphae throughout. Pycnidia developing quickly within and upon the agar in lines radiating from the center of the colony; conspicuously ostiolate, dark brown to black; their numerous pink spores exuded in droplets and giving the center of the culture a moist rose-colored appearance for a few days, then becoming drab and superseded by dark clumps of aerial hyphae and chains of *Alternaria* spores, which appear within three days.

<sup>5</sup> Benham, Rhoda. *Phoma conidiogena*. Bull. Torrey Club 58: 203-214. 1931.

*On Dextrose Agar:* Culture consistently rose-colored and moist with masses of pycnospores; fading somewhat with age. Submerged hyphae hyaline. No aerial hyphae and no *Alternaria* spores.

*On Potato Dextrose Agar:* Colony at first rose-colored with moist masses of pycnospores, becoming black with age. No aerial hyphae and no *Alternaria* spores.

*On Czapek's Agar:* Similar to colonies on corn meal, but with

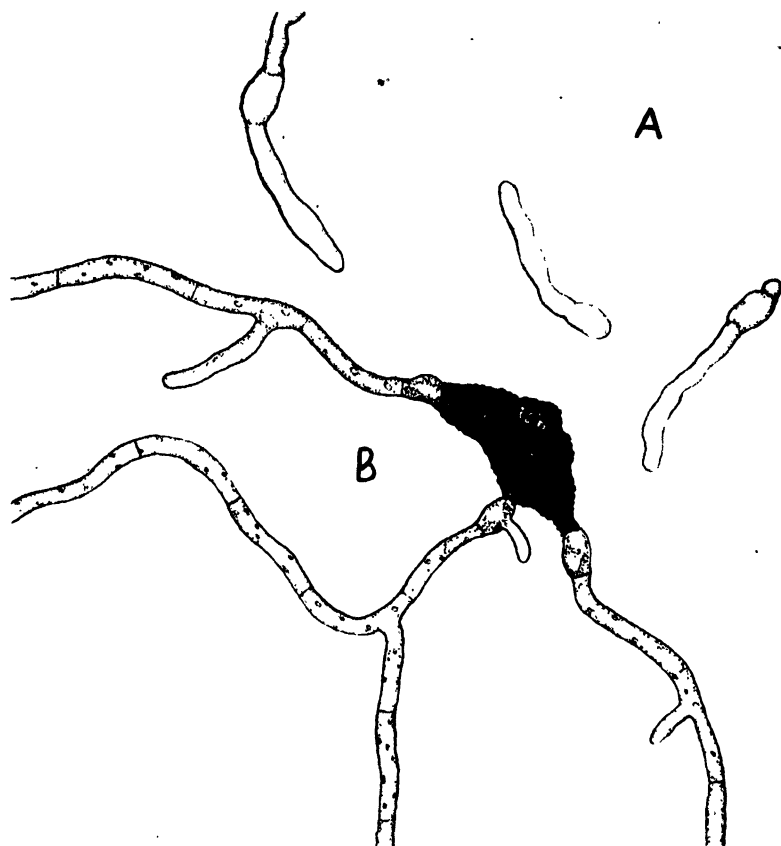


FIG. 2. Germinating spores after ten hours on corn meal agar at 25° C  
A, *Phoma*; B, *Alternaria* ( $\times 1000$ ).

more abundant and lighter-colored aerial hyphae. In age becoming entirely black and crusted.

*Spore Germination:* On corn meal agar the pycnospores are



slower to germinate than the *Alternaria* spores. They start growing within eight hours, when incubated at 25° C., sending out one to several germ tubes, as illustrated in figure 2, which soon begin to septate and branch. Germination tubes break through the thick wall of the dark *Alternaria* spore within five hours. Any or all of the cells of the spore may produce a tube. Figure 2 shows the two kinds of spores from the same single spore culture after they had been incubated at 25° C. for ten hours.

#### MORPHOLOGICAL FEATURES

Pycnidia dark brown to black, ostiolate, 37–150  $\mu$  in diameter, average 72.6  $\mu$ , with ostiolate portion often forming a neck about 33  $\mu$  long; developing in radiate formation. Pycnosporos abundant, at first rosy in mass, becoming drab, individuals hyaline, irregularly oval to elliptical, often bi-guttulate, average  $5 \times 2.5 \mu$  (PLATE 4, F).

*Alternaria* spores dark brown to black, rough-walled, average  $36.6 \times 13.6 \mu$  (often much larger), with 4–9 transverse and 2–5 longitudinal walls, produced in abundantly branching chains in dark entangled clumps, often growing directly from pycnidium wall (PLATE 4, D, E, H, I).

Mycelium hyaline to dark greenish brown with *Oidium*-like chains of thickened cells in old cultures.

Pycnidial stage found on dead tips of leaves and on dead twigs of *Buxus sempervirens* var. *angustifolia* in The New York Botanical Garden. Specimens and cultures deposited in The New York Botanical Garden Herbarium and Fungus Culture Collection.

#### MUTANTS

Chodat <sup>4</sup> reports frequent mutations in his cultures of *Phoma alternariaceum* Brooks & Searle, expressed by sectoring of plate colonies into areas contrasting in degree of fertility, character of aerial mycelium, etc. His stock culture produced a more fertile sector after thirteen months of culturing. In view of this record the present cultures were watched for any such phenomenon. After nine months of frequent transferring, including three months in storage at approximately 45° F., a case of sectoring was noted. In a plate transfer from a single *Alternaria*

spore culture, a portion representing about one-third of the colony remained almost sterile, with considerable white flocculent aerial hyphae contrasting sharply with the rest of the growth which was of the normal greenish-brown color with both *Phoma* and *Alternaria* spores. A transfer from this sterile portion to another plate showed after several days three dark brown pycnidia at the center of the colorless colony. After a month the mycelium gradually took on a slightly dusky greenish color with aggregations of dark submerged mycelium and white aerial tufts, but no further tendency toward fertility has appeared in any of its subcultures on corn meal agar. On dextrose and potato dextrose agar, however, abundant pycnidia are produced. No *Alternaria* spores have been observed on any medium.

Fifteen single spore cultures from a pycnidium of the first subculture of this "sterile" sector developed into hyaline submerged colonies with the vortex-type of growth described by Schnegg<sup>2</sup> for his fungus. Pycnidia with spores developed in four days, but little aerial mycelium and no *Alternaria* spores were present. After several months in culture these colonies have darkened and look much like the original stock strain, except for the lack of *Alternaria* spores. Further single spore cultures are identical.

If these strains appear in artificial culture, they might be expected also to occur in nature. All isolations from boxwood have been approximately alike except one made in May, 1931. In this case the pycnidia are somewhat larger, less abundant, less regularly arranged on the radiate hyphae, and more frequently suspended in the aerial growth than in any other culture. The *Alternaria* type of spore is much less abundant.

#### INOCULATIONS

Attempts have been made to reproduce the spotting on the boxwood leaves both indoors and outdoors without success. In one instance the fungus was re-isolated after two weeks from a small necrotic area about the point of inoculation, but typical symptoms did not develop. It would seem that only under certain conditions perhaps of the host as well as of its environment will the fungus affect boxwood tissue. Moreover, since the leaf spot is apparently limited to one variety, and since new growth

is not attacked early in the season even on bushes where the older leaves are generally affected, the fungus must be considered only a weak parasite taking hold, perhaps, after a primary injury of some sort.

#### SUMMARY

1. A strain of *Phoma conidiogena* Schnegg was isolated from dead leaf tips and from blighted twigs of *Buxus sempervirens* var. *angustifolia* at The New York Botanical Garden. The necrotic areas on the leaf are at the extreme tip, ashy white, very thin and dried, and show ostiolate pycnidia on both surfaces.

2. New leaves are not quickly infected and the fungus appears to be only weakly parasitic on old weakened tissue.

3. Single spore cultures of the fungus produce spores of both the *Phoma* and *Alternaria* types. Other strains of this fungus have been reported as present in brewery liquids, rotting tomato fruits and cellar air, but no previous record of its occurrence on boxwood has been found.

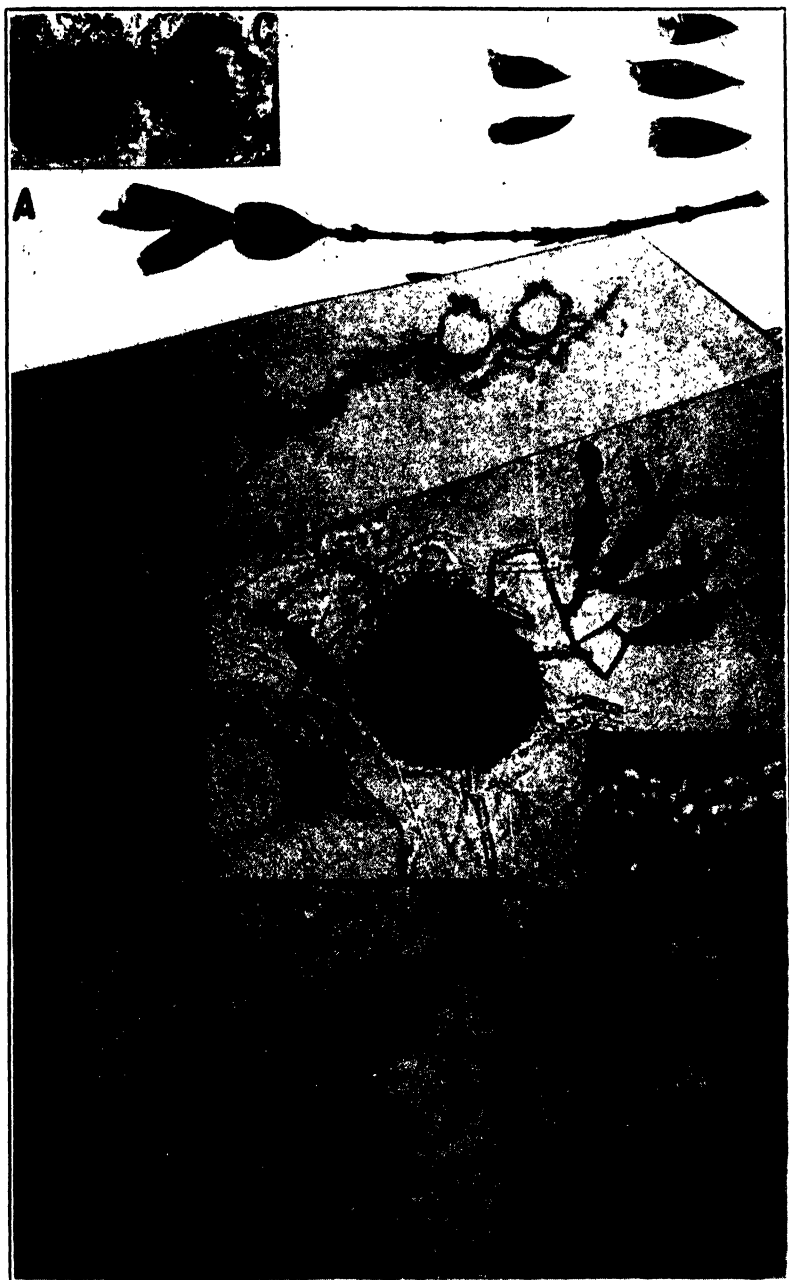
4. Sectoring occurred in a single spore plate culture after nine months of transferring. Subcultures from the almost sterile sector develop very few pycnidia on stock corn meal agar as compared with the original strain, and no *Alternaria* spores on any medium. Single spore cultures from these pycnidia show vegetative characteristics very similar to the original strain, but still consistently lack the *Alternaria* type of spore.

The helpful suggestions of Dr. B. O. Dodge in the preparation of this paper are gratefully acknowledged.

THE NEW YORK BOTANICAL GARDEN

#### EXPLANATION OF PLATE 4

A, Boxwood leaves infected with *Phoma conidiogena*. B, Section of diseased leaf tip. (× 350.) C, Pycnidia on leaf tissue. (× 200.) D, *Alternaria* spores and *Phoma* pycnidium from single spore culture. (× 400.) E, Same as D. (× 250.) F, *Phoma* spores. (× 1000.) G, Ostiolate pycnidia in young culture with masses of discharged spores. (× 100.) H, *Alternaria* spore chains growing from pycnidia in older culture. (× 100.) I, Tufts of aerial *Alternaria* spores in old culture. (× 100.)



PHOMA CONIDIOGENA



# PHYSIOLOGIC SPECIALIZATION IN PUCCINIA EATONIAE

E. B. MAINS<sup>1</sup>

In 1903, Arthur (1904) noted the association of aecia (*Aecidium Ranunculi* Schw.) on *Ranunculus abortivus* L. with uredinia on the grass *Sphenopholis pallens* (Spreng.) Scribn. (*Eatonia pennsylvanica* A. Gray). He sowed aeciospores from *Ranunculus abortivus* on rust-free plants of *Sphenopholis pallens* in the greenhouse and obtained uredinia and, later, telia. Arthur noted that this was one of the numerous grass rusts passing under the name of *Puccinia rubigo-vera* (DC.) Wint. Since the name *Puccinia Ranunculi* was preoccupied, he proposed the name *Puccinia Eatoniae* for this rust.

## EXPERIMENTAL RESULTS

The teliospores of most of the rusts of the *rubigo-vera* group usually germinate in the spring following their production, after having overwintered. The aecia of most of these rusts are usually localized and are produced in about 10 to 14 days after inoculation. The teliospores of *Puccinia Eatoniae* germinate in late summer or autumn of the year in which they develop and infection of the aecial host must occur, if at all, at that time. Aecia are found in the spring arising from a systemic mycelium. The rust, therefore, must pass the winter as mycelium in the *Ranunculus* host. In order to complete the studies of Arthur and obtain more information concerning this portion of the life history, it was decided to attempt cultures from the teliospores to *Ranunculus abortivus*. Two collections of telia were used for this purpose.

Telia of the first lot were collected on *Sphenopolis pallens* near Lafayette, Indiana, on June 17, 1920. These were stored out

<sup>1</sup> These studies were made while the writer was located in the Agricultural Experiment Station of Purdue University and were part of the coöperative investigations between that institution and the Office of Cereal Crops and Diseases of the United States Department of Agriculture.

doors and tested at intervals until September 16, when the teliospores showed germination. The germinating teliospores were used to inoculate young plants of *Ranunculus abortivus*, *R. californicus* Benth., *R. scleratus* L., *R. Cymbalaria* Pursh., *R. acris* L., and *R. repens* L., all of which are known to be aecial hosts of grass rusts of the *rubigo-vera* type. Seven plants of noninoculated *R. abortivus* were kept as checks. The plants were retained in the greenhouse. During the autumn and early winter no sign of infection was noted. On January 3, 1921, several of the inoculated plants of *R. abortivus* showed thickening of some of the leaves. On January 28, pycnia showed on some of the lower leaves of a few of the plants. Finally, 11 of the 15 inoculated plants of *R. abortivus* showed pycnia occurring on most of the leaves of the rosette. In most cases all of the leaves were involved. Occasionally a few leaves were free or only partially invaded. With the development of pycnia a fragrant odor was noted.

Aecia were first noted on March 21 and their development advanced rapidly until the lower surfaces of most of the leaves were covered. None of the noninoculated check plants of *R. abortivus* developed rust. The inoculated plants of *R. californicus*, *R. scleratus*, *R. Cymbalaria*, *R. acris*, and *R. repens* did not develop infection.

Telia of the second collection were obtained by Prof. H. S. Jackson, July 1, 1920, at Vincennes, Ind. Nine plants of *R. abortivus* were inoculated from germinating teliospores of this collection on September 16, 1920. Two plants showed a few pycnia on October 26 but during November and December further development of the rust apparently ceased. On January 28, 1921, all nine plants had pycnia on the lower leaves, followed soon by their appearance on the other leaves of the rosettes. Aecia were first noted March 21 and soon afterward they covered the lower sides of infected leaves.

Aeciospores from the second series of cultures were used to inoculate a series of grasses. On March 26, they were sown on 10 or more seedlings of *Alopecurus pratensis* L., *Arrhenatherum elatius* (L.) Beauv., *Festuca ovina* L., *F. rubra* L., *Dactylis glomerata* L., *Poa palustris* L., *P. trivialis* L., *Puccinellia Nuttalliana*

(Schultes) Hitchc., *Sphenopholis obtusata* (Michx.) Schribn., and *S. pallens*. Uredinia developed only on *S. pallens* which showed an abundant infection, April 7, 1921.

Urediniospores from the rust thus obtained on *S. pallens* were sown April 21 on seedlings of *Danthonia californica*, *Deschampsia flexuosa* Trin., *Notholcus lanatus* (L.) Nash, *Panicularia elata* Nash, *Poa palustris*, *Puccinellia Nuttalliana*, *Sphenopholis obtusata* and *S. pallens*, with development of uredinia only on *S. pallens*.

In May, 1921, H. W. Anderson collected the aecial stage of a rust near Odin, Ill., on *Myosotis virginica* (L.) B.S.P. The aecia covered the lower sides of most of the leaves and apparently arose from a systemic mycelium. H. S. Jackson determined this collection as *Aecidium Myosotidis* Burr. This *Aecidium* was described by Burrill (1884) from a collection made at Cobden, Ill., by A. B. Seymour, April 13, 1882. Since the material in the Arthur Herbarium was fragmentary, Jackson asked Anderson to compare his collection with the type material at the University of Illinois. This was done and the rust was found to agree with the type of *Aecidium Myosotidis* and with several other collections made by Seymour at Cobden and Makanda, Illinois, during April, 1882.

The systemic aecia on *Myosotis* immediately suggested the similar aecia on *Ranunculus abortivus*. Since among the grass rusts of the *rubigo-vera* type there exists a number of very similar types some of which have aecia on Boraginaceous hosts and others on species of Ranunculaceae, this suggested a grass as the alternate host with the possibility that it might be *Sphenopholis*. Consequently, Professor Anderson was asked to look for rust on other plants in the vicinity of the rusted *Myosotis*. He very kindly did so and sent in two grasses bearing uredinia. One of these proved to be *Sphenopholis obtusata* and the rust resembled *Puccinia Eatoniae*.

Fortunately, Professor Anderson was able to obtain fresh aecia on *Myosotis virginica* at Odin, Illinois, which he sent to us. On May 16, aeciospores were sown on seedlings of *Sphenopholis obtusata*. A few uredinia developed on May 26 and the spores from these were sown on other plants of *S. obtusata*, resulting in



abundant infection. During the summer this rust was resown several times upon the same plants resulting finally in the production of abundant telia.

The rust was tried also on a number of other grasses. On August 24, urediniospores from *Sphenopholis obtusata* were sown on seedlings of *Koeleria cristata* (L.) Pers., *Arrhenatherum elatius*, *Notholus lanatus*, *Bromus inermis* Leyss., *B. tectorum* L., and *Sphenopholis obtusata* resulting in the production of uredinia only on *S. obtusata*.

On September 7, urediniospores from *S. obtusata* were sown on *Avena barbata* Brot., *A. fatua* L., *Bromus inermis*, *B. tectorum*, *Deschampsia caespitosa* (L.) Beauv., *Secale cereale* L. (Petkus variety), *Sphenopholis obtusata* and *S. pallens* resulting in the production of uredinia only on *S. obtusata* and *S. pallens*.

Teliospores developed on *Sphenopholis obtusata* were germinated in November and were used in the greenhouse on November 3 to inoculate seedlings of *Myosotis virginica*. The teliospores, still germinating, were used for a second series of inoculations December 3, on both *Myosotis virginica* and *Ranunculus abortivus*. A third inoculation was made December 20 on *Myosotis virginica*.

The first signs of infection were noted with the renewal of vigorous growth in January. The shoots of infected plants were more elongated than those of the check plants. Pycnia first appeared February 25, 1922, on plants of *Myosotis* from the second inoculation. By March 6, pycnia were showing on all of the plants of *Myosotis* from all three inoculations. The infected plants soon showed pycnia covering most of the leaves of the inoculated *Myosotis virginica*. The development of pycnia was accompanied by a fragrant odor as noted for *Ranunculus abortivus*. Aecia were first noted April 14 and soon covered the lower sides of the leaves of infected plants. All 15 plants of the inoculated *Myosotis virginica* produced abundant systemic infection, while the 5 noninoculated check plants showed no sign of rust. The 7 inoculated plants of *Ranunculus abortivus* showed no infection.

Aeciospores from *Myosotis virginica* were sown on *Sphenopholis obtusata* April 20 and abundant uredinia were produced by April 30.

## TAXONOMIC POSITION

It has been suggested that many of the grass rusts, such as *Puccinia triticina* Eriks., *P. Elymi* Westend., *P. Agropyri* Ellis & Ev., *P. persistens* Plowr., *P. cinerea* Arth., etc., of very similar morphology, should be united under one specific designation. Thus, Arthur and Fromme (1920) have united such grass rusts having Ranunculaceous aecia under *Dicaeoma Clematidis* (DC.) Arth. Cunningham (1923) has concurred in this but considers that the name *Puccinia Elymi* should be used, since *Aecidium Clematidis* DC. was based on an aecial stage. Mains and Jackson (1926) have suggested that the closely similar grass rusts having aecia on species belonging to the Boraginaceae (*Puccinia dispersa* Eriks. & Henn., *P. bromina* Eriks.), Hydrophyllaceae (*P. apocrypta* Ellis & Tracy) and Balsaminaceae (*P. Impatientis* (Schw.) Arth.) also should be included and have suggested a return to the earlier name *Puccinia rubigo-vera* (DC.) Wint. As so used it does not include the species *Puccinia glumarum* (Schmidt) Eriks. & Henn. and *Puccinia anomala* Rostr. which were formerly included.

Morphologically, the rusts of *Sphenopholis-Ranunculus* and of *Sphenopholis-Myosotis* do not differ markedly from the majority of the rusts of the *rubigo-vera* group. They have globoid or ellipsoid urediniospores with six or more scattered germ pores, and teliospores that remain covered for some time by the epidermis. While the teliospores of most of the rusts of the *rubigo-vera* group usually do not germinate until spring, the early germination of the teliospores of *Puccinia Eatoniae* finds its counterpart in the leaf rust of rye. However, in the production of pycnia and aecia from a systemic mycelium *Puccinia Eatoniae* differs sufficiently from *Puccinia rubigo-vera* to be maintained as a separate species. It is, however, a very closely related species, as is shown by its general morphology and by the occurrences of races in both species having aecia on Ranunculaceous and Boraginaceous hosts.

A comparison of *Puccinia Eatoniae* derived from *Ranunculus* and *Myosotis* shows a very close agreement in morphology as well as development. This can be noted by comparing the following descriptions. The rust from *Ranunculus* has much longer teliospores, 28–50  $\mu$ , as compared with 23–35  $\mu$  of that from *Myo-*

*sohis*. Whether this difference will be maintained when more extensive material is available is a question which must await further study. For the present it seems best to consider these rusts as separate varieties of *Puccinia Eatoniae*, that with aecia on *Ranunculus abortivus* being designated as *Puccinia Eatoniae* var. *Ranunculi* and that with aecia on *Myosotis virginica* as *Puccinia Eatoniae* var. *Myosotidis*.

***Puccinia Eatoniae* var. *Ranunculi* (Schw.) comb. nov.**

Syn. *Aecidium Ranunculi* Schw.

O. Pycnia scattered over large areas of the leaves from a systemic mycelium.

I. Aecia hypophyllous accompanying the pycnia, cupulate, up to 0.6 mm. in diameter; peridium colorless, short, the margin slightly recurved; peridial cells rhomboidal  $12-24 \times 21-31 \mu$ ; aeciospores globoid or ellipsoid,  $12-17 \times 15-24 \mu$ , the wall colorless, about  $1.5 \mu$  thick, finely verrucose.

On *Ranunculus abortivus*

II. Uredinia scattered on the leaves, small 0.3–0.7 mm. long, cinnamon-brown; urediniospores ellipsoid or globoid,  $15-19 \times 19-25 \mu$ ; wall yellow,  $1-1.5 \mu$  thick, closely and finely echinulate, the pores 6–8, scattered.

III. Telia scattered on leaves and leaf sheaths, 0.3–0.7 mm. long, brownish black, long covered by the epidermis; teliospores surrounded by brown stromal hyphae, germinating during the season when produced, oblong-clavate  $13-22 \times 28-50 \mu$ , rounded or flattened at the apex, the wall thin  $1 \mu$ , light chestnut brown, thickened at the apex up to  $6 \mu$ ; pedicel short.

On *Sphenopholis pallens*. Rather widely distributed throughout the eastern United States.

***Puccinia Eatoniae* var. *Myosotidis* (Burrill) comb. nov.**

Syn. *Aecidium Myosotidis* Burrill.

O. Pycnia scattered over large areas of the leaves from a systemic mycelium.

I. Aecia hypophyllous accompanying the pycnia, cupulate, up to 0.6 mm. in diameter; peridium colorless, short, the margin slightly recurved; peridial cells rhomboidal,  $17-23 \times 26-28 \mu$ ;

aeciospores angularly globoid,  $15-20 \times 18-25 \mu$ ; wall colorless, about  $2 \mu$  thick, finely verrucose.

On *Myosotis virginica*

II. Uredinia on the leaves, scattered, small, light cinnamon-brown; urediniospores broadly ellipsoid  $15-21 \times 19-25 \mu$ ; wall pale brown, about  $1.5 \mu$ , finely echinulate, the pores 6-8 scattered, indistinct.

III. Telia on the leaves and leaf sheaths, scattered, brownish black, long covered by the epidermis, germinating during the season when produced, oblong-clavate,  $13-18 \times 25-35 \mu$ , often flattened at the apex; wall thin, about  $1 \mu$ , light brown, thickened at the apex up to  $3 \mu$ , chestnut brown; pedicel short.

On *Sphenopholis obtusata* and *S. pallens*

Judging from the distribution of the aecia (Arthur, 1926), this variety occurs in Indiana, Illinois, Missouri, and Wisconsin.

SUMMARY

*Puccinia Eatoniae* has been shown to contain two varieties which have been designated as *Ranunculi* and *Myosotidis*.

*Puccinia Eatoniae* var. *Ranunculi* produced aecia on *Ranunculus abortivus* but not on *Ranunculus californicus*, *R. scleratus*, *R. Cymbalaria*, *R. acris* nor *R. repens*. Infection from basidiospores takes place in late summer or early autumn and aecia develop from a systemic mycelium the following spring. Uredinia and telia were produced on *Sphenopholis pallens* but not on *Alopecurus pratensis*, *Arrhenatherum elatius*, *Dactylis glomerata*, *Danthonia californica*, *Deschampsia flexuosa*, *Festuca ovina*, *F. rubra*, *Notholcus lanatus*, *Panicularia elata*, *Poa palustris*, *Poa trivialis*, *Puccinellia Nuttalliana*, nor *Sphenopholis obtusata*.

*Puccinia Eatoniae* var. *Myosotidis* produced aecia on *Myosotis virginica* but not on *Ranunculus abortivus*. Teliospores germinated in late summer and early autumn and aecia developed from a systemic mycelium the following spring. Uredinia and telia were produced on *Sphenopholis obtusata* and *S. pallens*, but not on *Avena barbata*, *A. fatua*, *Bromus inermis*, *B. tectorum*, *Deschampsia caespitosa*, *Koeleria cristata*, *Notholcus lanatus* nor

*Secale cereale*. This variety also was found to have shorter teliospores than the variety *Ranunculi*.

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## ON CERTAIN SPECIES OF HETEROTEXTUS

G. W. MARTIN

(WITH PLATE 5)

The genus *Heterotextus* was proposed by C. G. Lloyd<sup>1</sup> to include certain dacryomycetaceous fungi previously referred to *Guepinia*, but differing from typical members of that genus, as it has ordinarily been understood, in the possession of a firm cortical layer composed of swollen, bottle-shaped or subcylindrical cells arranged in a palisade layer and quite distinct from the loosely interwoven and highly gelatinized tissue composing the interior of the basidiocarp. The first species mentioned is *H. flavus* Lloyd, from Tasmania, described as new. Lloyd also transfers to his new genus *Guepinia pezizaeformis* Berk., *G. monticola* Tracy and Earle and *G. occidentalis* Lloyd.

In the coniferous forests of the Rocky Mountains of Colorado and Wyoming, one of the commonest fungi occurring on decorticated logs of *Picea* and *Abies* is a cupulate dacryomycetaceous form clearly belonging to Lloyd's genus. The attempt to name abundant collections in the herbarium of the State University of Iowa brought out the confusion existing in this group of species. The specimens were in part collected by myself in the Medicine Bow Mountains, Wyoming, in August, 1929; in part by Mr. R. W. Davidson of the United States Department of Agriculture, in Colorado, in June and July 1930.

In 1905, Tracy and Earle<sup>2</sup> described *Guepinia alpina* and *G. monticola* from the mountains of southwestern Colorado, where both were growing on the wood of *Picea Engelmanni*. According to the original descriptions the two species are very nearly alike. Both are said to be cup-shaped, short stipitate, of about the same size and with similar basidia and spores. It is true the description says of *alpina*, "basidia . . . forking at base," and of *monticola*, "basidia forking near the upper end," but I interpret this

<sup>1</sup> Myc. Notes 7: 1151. 1922.

<sup>2</sup> Fungi. In Greene, Plantae Bakerianae 1: 23. 1901.

to mean merely that the basidia of *G. alpina* were younger and cylindrical, and hence their tufted habit was more apparent in a crushed mount. Since the spores of both were described as unseptate, they must have been immature. This is stated for *G. alpina* and there is a question mark after "continuous" in the case of *G. monticola*. *G. alpina* is said to be orange yellow, *G. monticola* "ferruginous," but the condition when collected and the manner of drying often affects the color of both fresh and dried specimens belonging to this family. So far as the descriptions are concerned, therefore, the only significant difference is the character of the vesicular hairs which clothe the outer part of the fructification, those of *G. alpina* being described as " $50 \times 16 \mu$ , simple or sometimes once septate and constricted, minutely roughened"; those of *G. monticola* as " $50 \mu$  long with base globose,  $20\text{--}25 \mu$  wide, abruptly compacted above into a long beak." The outside of the cup of *G. alpina* is said to be pruinose, that of *G. monticola* "sulcate ribbed, surface scarcely distinguishable from the hymenium."

Through the kindness of Dr. David H. Linder I have been permitted to examine co-types of both species from the herbarium of the Missouri Botanical Garden, and Dr. Bessie B. Kanouse courteously loaned me all material ascribed to these species in the University of Michigan herbarium. Examination of these specimens confirms the conclusion arrived at from examination of our own abundant material, that the differences as given are not constant, but represent slightly different phases of a single species. The pruinose character of the outer margin varies with the age and state of development of the fructification, while hairs of all sorts forming a completely connected series may be found in a single mount, almost in a single cluster (PLATE 5, FIGS. 3, 4, 11, 15). In the Michigan herbarium there is a collection made by J. R. Weir in Bonner County, Idaho, June, 1920, labelled by Dr. Weir "*Dacryomyces alpina* Tracy and Earle, subsp. of *D. monticola* T. & E." This is clearly *Guepinia alpina* T. & E. Dr. Weir further notes on the packet that *G. alpina* is "olive yellow," *G. monticola*, "amber, no yellow." As already suggested, great variation in color may be noted in the fructifications of different ages in the same cluster.

In my opinion, *Heterotextus*, as defined by Lloyd, is a good genus, readily distinguished from other genera of the Dacryomycetaceae by the character given. *Guepinia alpina* and *G. monticola* are described on the same page, but since *G. alpina* comes first it has priority. Curiously enough, Lloyd failed to include *G. alpina* in his list of species transferred to *Heterotextus*. I have the less hesitation in making this transfer, since it seems clear that *Guepinia* of Fries is a genus of the Tremellaceae. The only species cited in the original description<sup>3</sup> is *G. helvelloides*, which is evidently the large infundibuliform fungus more generally known by Persoon's name as *Gyrocephalus rufus*. This citation is confirmed in the Elenchus Fungorum (2: 30), where it is the first of two species of *Guepinia* cited, the second being *G. spathularia*. Since *G. helvelloides* (i.e. *Gyrocephalus rufus*) has cruciate-septate basidia, it must be included in the Tremellaceae, and Patouillard was wholly justified, by any reasonable interpretation of the International Code, in transferring *Guepinia spathularia* and related species with forked basidia to his new genus *Guepiniopsis*. Lloyd believes (Myc. Notes 7: 1143) that Fries misapplied the specific name, but even if this were so, and it can scarcely be said to have been demonstrated, the interpretation would be unaffected. I therefore propose the following combination to designate the Rocky Mountain species:

***Heterotextus alpinus*** (Tracy & Earle) comb. nov.

Fructification cup-shaped, becoming expanded, bright orange to amber or pallid when moist, deep orange red when dry; 3–10 mm. in diameter when moist, and about the same in depth, exterior more or less sulcate ribbed, the exterior of the expanded portion roughened and more or less tuberculate; hymenium concave, smooth or nearly so, composed of forked basidia 40–50  $\mu$  long before branching and 4–5  $\mu$  thick; cortex composed of a palisade layer of vesicular hairs, mostly 40–75  $\mu$  in length and 15–20  $\mu$  thick, varying from broadly pyriform to nearly cylindrical, with a small lumen, and thick, gelatinized walls, rough exteriorly, often elongated at the apex into a beak; interior of fructification composed of loosely interwoven, extremely gelatinous hyphae,

<sup>3</sup> Syst. Orbis Veg. 92. 1825.



with numerous clamp connections; spores allantoid, apiculate, at first continuous, becoming 4-celled,  $15-17.5 \times 5-6 \mu$ .

On *Picea Engelmanni* and *Abies* sp., Colorado, Wyoming, Idaho.

The tubercular character of the exterior is most apparent when the fructifications are not too moist (PLATE 5, FIGS. 1, 6). The hymenium is probably always inferior, but this cannot be determined positively from herbarium specimens. The clamp connections are very conspicuous, sometimes with a large open loop (PLATE 5, FIG. 5). The spore measurements as given in the original descriptions are  $12 \times 4 \mu$  for *G. alpina*, and  $12-16 \times 4 \mu$  for *G. monticola*. No septate spores were found in the co-type of *G. monticola*, and the largest immature spore measured was  $16 \times 5 \mu$  (PLATE 5, FIG. 12). A few mature, 4-celled spores were found in the co-type of *G. alpina*. A typical example (PLATE 5, FIG. 16) measured  $17 \times 5.5 \mu$ .

It is noteworthy that it was impossible to find septate spores in many of our own specimens, while in others, obviously more mature, 4-celled spores were abundant (PLATE 5, FIG. 8). Apparently the spores mature with unusual slowness.

*Ditiola Shopei* Coker, described from material collected on *Picea Engelmanni* in Colorado,<sup>4</sup> seems unquestionably the same as *Heterotextus alpinus*. Coker describes the spores as mostly not divided, some divided into two cells, rarely into four. The late appearance of completely divided spores has already been noted as characteristic of *H. alpinus*. Evidently, the spores are capable of germinating before final division, since Coker illustrates an unseptate spore and a 2-celled spore producing germ-tubes. This I have not observed.

Two specimens in the Michigan herbarium, collected by Dr. Kauffman at Lake Placid, N. Y., belong in *Heterotextus*. One was identified by Dr. Kauffman as *G. alpina*, the other as *G. monticola*. Part of the latter collection was evidently sent to Mr. Lloyd, since there is a note on the packet, "Lloyd suggests *G. alpina* or *G. pezizaeformis*." Both collections are clearly referable to the same species, and this cannot be *G. alpina*. The fructifications, although fully developed, are much smaller (PLATE

<sup>4</sup> Jour. Elisha Mitchell Soc. 46: 117. 1930.

5, FIG. 17), and the cortical hairs are ovate to cylindrical and very much smaller than those of *G. alpina*, rarely exceeding  $30\ \mu$  in length and  $7\text{--}12\ \mu$  in thickness, and only occasionally with a blunt, beak-like apex (PLATE 5, FIG. 21). The spores, too, are smaller, about  $13\text{--}14 \times 5\text{--}6$ , and somewhat more curved (PLATE 5, FIGS. 19, 22). The specimens do agree very closely with the descriptions of *Guepinia Peziza* Tulasne as that species has been understood by recent authors, notably Schroeter<sup>5</sup> and Lloyd,<sup>6</sup> although Lloyd gives the spore measurements as  $14 \times 7\ \mu$ . I therefore refer them to that species.

Certainly *Guepinia Peziza*, as illustrated by its author,<sup>7</sup> is to be included in *Heterotextus*, if that genus is to be accepted. I do not wish to propose such a transfer, however, without having had the opportunity to study authentic material.

*Heterotextus pezizaeformis* (Berk.) Lloyd seems to have been reported only from Australia and New Zealand. Little can be told from Berkeley's brief diagnosis as given in Saccardo (6: 807) and Lloyd's comments are not always clear. It seems to be entirely too close to *Guepinia Peziza*, but Lloyd, who knew both species, thought them distinct. It is to be hoped that his material will be re-examined, and the differences, if such exist, be plainly stated.

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#### EXPLANATION OF PLATE 5

All figures showing microscopical details outlined with camera lucida and reduced in reproduction to magnification indicated.

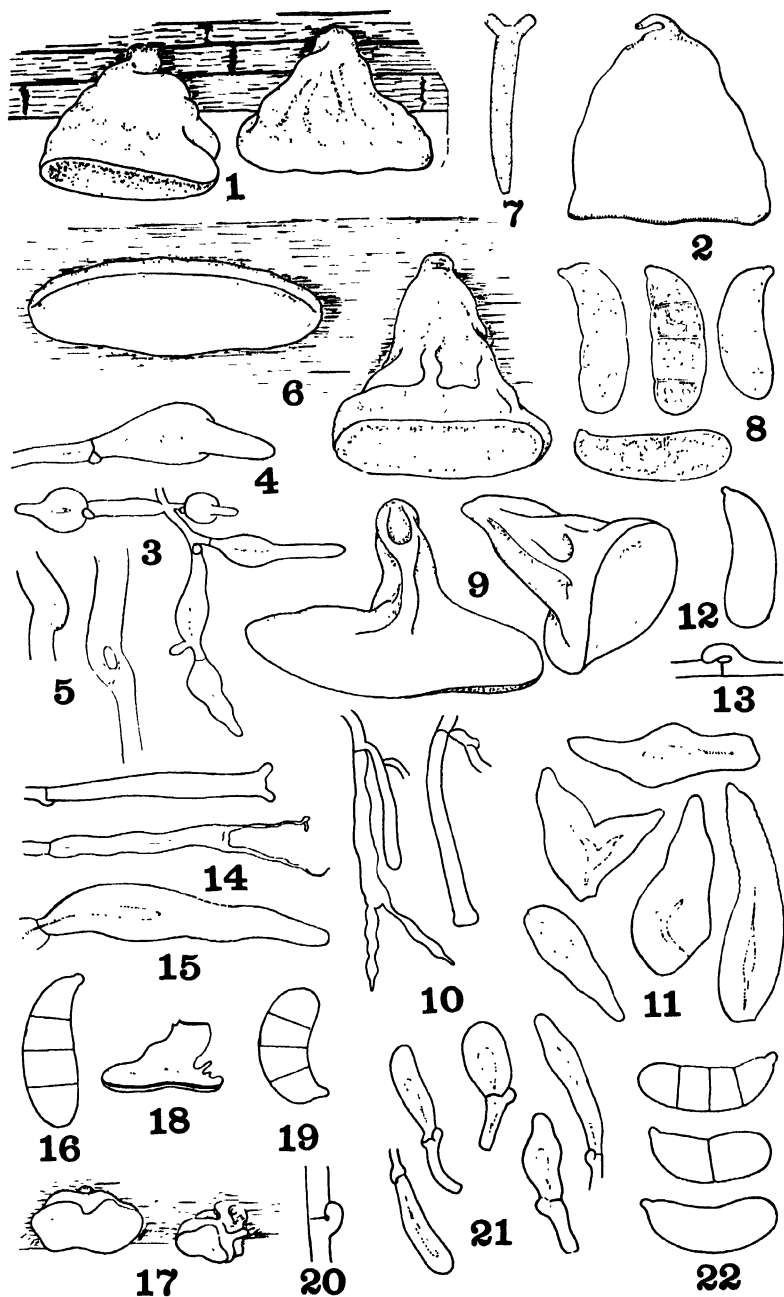
Figs. 1-16, *Heterotextus alpinus*: 1, R. W. Davidson, No. 206, Colorado. Two basidiocarps, showing tuberculate character,  $\times 5$ ; 2, Same. Longitudinal section, showing internal zonation,  $\times 5$ ; 3, Same. Cluster of cortical hairs, showing variation,  $\times 252$ ; 4, Same. Cortical hair,  $\times 505$ ; 5, Same. Two clamp connections, one looped,  $\times 1218$ ; 6, G. W. Martin, No. 375, Wyoming. Two basidiocarps, one showing sulcate peridium, the other fully mature and broadly expanded,  $\times 5$ ; 7, Same. Basidium,  $\times 505$ ; 8, Same. Four spores,  $\times 1218$ ; 9, Co-type of *Guepinia monticola*. Two basidiocarps,  $\times 5$ ; 10, Same. Three basidia, one young, one ready to produce epibasidia, one

<sup>5</sup> Pilze Schlesiens. 1888.

<sup>6</sup> Mycological Notes 6: 921. 1920.

<sup>7</sup> Ann. Sci. Nat. V. 15: Pl. 9. 1872.

shrunk after having discharged spores; 11, Same. Five cortical hairs, showing variation,  $\times 505$ ; 12, Same. Spore,  $\times 1218$ ; 13, Same. Clamp connection,  $\times 1218$ ; 14, Co-type of *Guepinia alpina*. Two basidia,  $\times 505$ ; 15, Same. Cortical hair,  $\times 505$ ; 16, Same. Spore,  $\times 1218$ ; 17-22, *Guepinia Peziza*; 17, C. H. Kauffman, New York, as *Guepinia alpina*. Two basidiocarps,  $\times 5$ ; 18, Same. Longitudinal section of basidiocarp, showing internal zonation; 19, Same. Spore,  $\times 1218$ ; 20, Same. Clamp connection,  $\times 1218$ ; 21, C. H. Kauffman, New York, as *G. monticola*. Five cortical hairs,  $\times 505$ ; 22, Same. Three spores,  $\times 1218$ .





# NOTES ON TROPICAL RUSTS WITH DESCRIPTIONS OF TWO NEW SPECIES

ROSS W. DAVIDSON

(WITH 2 TEXT FIGURES)

The following rusts with a few exceptions were taken from the residue of W. A. Kellerman's Guatemalan collections. Arthur (1) cites 112 of Kellerman's collections saying that there still remains a large number of his specimens that have not yet been studied. The writer has studied what seems to be some of this remaining material and from it 150 determinations have been made.

By checking these specimens with the numbers and dates given in Arthur's paper, it was found that many were duplicates of those already studied. In most instances all data except numbers and date of collection were missing. S. F. Blake identified many of the hosts and others were determined from the rust present.

The interesting rust on *Senecio* sp. was found by S. F. Blake while examining some specimens of plants from Venezuela.

Specimens of the two new species have been sent to Dr. Arthur and he also believes them to be undescribed.

## 1. *Chrysocyclus Senecionis* sp. nov. (FIG. 1)

On *Senecio* sp. From Trujillo, Venezuela. Collected by Christ (No. 101) in 1927. Elevation 3,400-3,700 meters.

O. Pycnia hypophyllous, subepidermal, large, globose, 220-300  $\mu$  in diameter.

III. Telia on discolored spots 1-1.5 cm. across, hypophyllous, subepidermal, forming concentric circles around the pycnia, flat, slightly raised, dark cinnamon-brown, waxy in appearance, ruptured epidermis conspicuous; teliospores large, biapical from first (apex of lower cell arising below septum), 70-88  $\mu$  long, width (excluding apex of lower cell) 22-30  $\mu$ , width (including lower apex) 38-50  $\mu$ , length of upper cell 50-60  $\mu$ , from septum to base

22–32  $\mu$ , tapering slightly to the rounded apices, constricted at septum; wall uniformly 2–3  $\mu$  thick, light golden; pedicel hyaline, 12–18  $\mu$  thick, once to twice length of spore.

Pycnidiis hypophyllis, subepidermicis, globosis, 220–300  $\mu$  diam.; telii maculis brunneis 1–1.5 cm. insidentibus, hypophyllis, subepidermicis, concentric annuliformibus, applanatis, vix elevatis, cinnamomeo-brunneis, ceraceis, epidermide conspicue la-



FIG. 1. Teliospores of *Chrysocyclus Senecionis* ( $\times 170$ ).

cerata cinctis; teliosporis magnis, ab initio biapicalibus, 70–88  $\times$  23–30  $\mu$ , ad rotundatos apices attenuatis, septo constrictis; tunica 2–3  $\mu$  aequaliter crassa, pallide aurantia; pedicello hyalino, 12–18  $\mu$  crasso, sporam aequante vel duplo longiore.

In foliis *Senecionis*, Trujillo, Venezuela.

This species differs from both *C. Cestri* (Diet. & Henn.) Sydow and *C. Mikaniae* (Arth.) Sydow by having much broader and longer spores. The spores also differ by tapering to the rounded apices, and by having medium thick slightly colored walls. The biapical “mitten-like” condition, which is the most outstanding character of this interesting rust, is also much more pronounced than in the other species.

Jackson (5) considers the method of germination of the telio-

spores of previously described species of *Chrysocyclus* to be very similar to that in a number of species of lepto-*Puccinia* and concludes therefrom that generic separation can not be based on this character. However, it is the writer's opinion that the "mitten-like" form of the spores and waxy appearance of the sori, which are usually arranged in concentric layers around the pycnia, together with the method of germination are characters sufficiently distinctive to justify continuing the present classification.

#### PREVIOUSLY DESCRIBED SPECIES OF CHRYSOCYCLUS

*Chrysocyclus Cestri* (Diet. & Henn.) Sydow, Ann. Myc. **23**: 322, 1925.

*Puccinia Cestri* Diet. & Henn. Hedwigia 295, 1902.

*Chrysopsora Cestri* Arth. Bull. Torrey Club **51**: 53, 1924.

*Chrysocyclus Mikaniae* (Arth.) Sydow, Ann. Myc. **23**: 324, 1925.

*Chrysopsora Mikaniae* Arth. Bull. Torrey Club **51**: 54, 1924.

#### 2. CRASSOPSORA STEVENSII Sydow.

On *Fischeria* sp.? (Asclepiadaceae) Collected by W. A. Kellerman at Zacapa, Guatemala, Jan. 1, 1908.

This seems to be the first report of this rust occurring in Central America. F. L. Stevens (10) collected it on a species of Asclepiadaceae in British Guiana, and on *Echites tomentosa* Rafn. in Trinidad in 1922.

The host for this species belongs to the family Asclepiadaceae, but there is some doubt as to its generic position. S. F. Blake suggested *Fischeria* which is probably correct.

#### 3. SPIRECHINA PITTIERIANA (P. Henn.) Arth.

On *Rubus* sp. Collected by W. A. Kellerman near Guatemala City, Guatemala, Jan. 1, 1907.

This species has not been reported from Guatemala before. It is characterized by its large spiny urediniospores.

#### 4. RAVENELIA HUMPHREYANA P. Henn.

On *Caesalpinia pulcherrima* Sw. Collected by W. A. Kellerman at Aguacatan, Guatemala, Jan. 23, 1908.

This specimen is interesting because of the fasciation of the host tissue on which the rust occurs. The uredinia are scattered



abundantly on the distorted stems and on the floral parts. No previous account of the organism occurring on the stems or of its causing distortion in the host has been found. Kellerman (6) says, "No effect on the vitality or vigor of the host could be detected."

#### 5. SKIERKA HOLWAYII Arth.

On *Thouinidium decandrum* Radlk. Collected by W. A. Kellerman in the Valley of Rio Sanarate, Guatemala, Feb. 18, 1907.

There was an abundance of material in this specimen but since leaves only were present a determination of the host seemed doubtful. However, with S. F. Blake's suggestion of the family Sapindaceae, the writer was able to check it with specimens of *T. decandrum* in the National Herbarium.

One of these herbarium specimens collected by Standley in Honduras in 1922 bore an abundance of this same rust. Two other specimens containing the rust are also of interest from the standpoint of distribution: National Herbarium No. 2343, E. W. Nelson, Feb. 19, 1895, Oaxaca, Mexico, and No. 19891, P. C. Standley, Jan. 9-22, 1922, vicinity of Ahuachapan, Salvador.

#### 6. PUCCINIA CIRCINATA (Schw.) Arth.

On *Stigmaphyllon* sp. Collected by W. A. Kellerman at Sanarate, Guatemala, Jan. 11, 1906. No. 5897.

This was a second collection of this interesting rust by Kellerman. The first one was used by Arthur (1) in describing the telial stage.

#### 7. *Puccinia Laurifoliae* n. sp.<sup>1</sup> (FIG. 2)

On *Heteropteris laurifolia* (L.) Juss. Collected by W. A. Kellerman at Sanarate, Guatemala, Dec. 28, 1907. (Host determined by P. C. Standley.)

O & II. Pycnia and uredinia unknown (aecia probably not formed).

III. Telia amphigenous, scattered, round or oval, .2-.4 mm. diam., sometimes appearing larger from scattering of spores, pulverulent, epidermis rupturing in the center but not becoming

<sup>1</sup> This species is possibly the same as *Puccinia picturata* H. S. Jackson, The rusts of South America, Mycologia 23: 363, No. 5, which was published since this paper was written.

conspicuous; teliospores broadly ovoid ellipsoid, flattened, 35–45  $\mu$  long by 28–33  $\mu$  wide by 17–24  $\mu$  thick, rounded at both ends, not or slightly constricted at septum; septum oblique, wall becoming chocolate-brown at maturity, uniformly 2–3  $\mu$  thick, prominently verrucose with papillae arranged in definite lines which converge from the pedicel which is near the center of one flattened side to the center of the opposite side, lines 1.5 to 2  $\mu$  apart; pedicel light cinnamon-brown, up to 50  $\mu$  long, in water

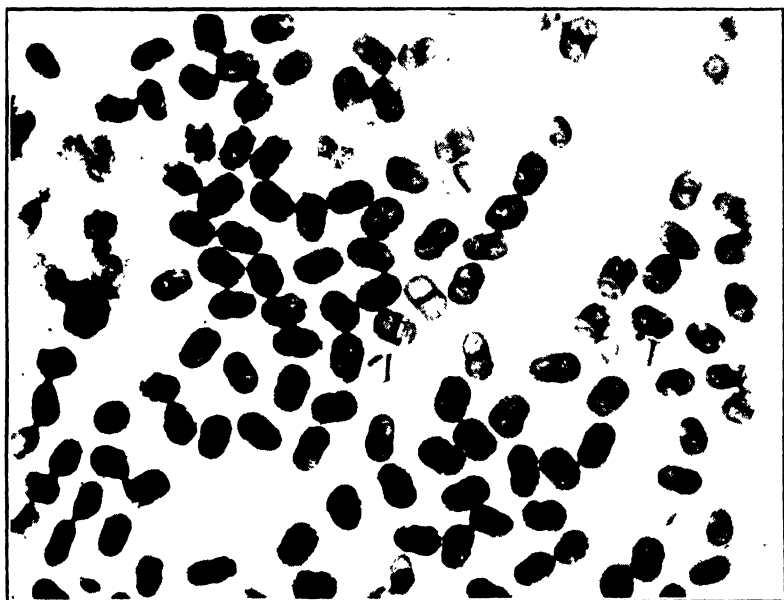


FIG. 2. Teliospores of *Puccinia Laurifoliae*.  $\times 170$ . Photomicrographs by J. F. Brewer.

swelling next to spore to form a bulbous enlargement 24  $\mu$  in diameter, attached laterally.

Teliis amphigenis, sparsis, rotundis vel ovatis, parvis, .2-.4 mm. diam., pulveraceis, epidermide centro inconspicue rupta cinctis; teliosporis late ovoideis-ellipsoideis, applanatis, 35–45  $\mu$  longis, 28–33  $\mu$  latis, 17–24  $\mu$  crassis, utrinque rotundatis, septo obliquo non vel leniter constrictis; tunica in maturitate atro-brunnea, 2–3  $\mu$  aequaliter crassa, conspicue verrucosa; papillis in striis convergentibus dispositis; pedicello pallide cinnamomeo-brunneo, usque 50  $\mu$  longo, laterali, in aqua vesiculososo-inflato.

In foliis *Heteropteridis laurifoliae*, Sanarata, Guatemala.

This species differs from *P. circinata* and other closely related species by having the peculiar striate markings of the teliospores and by the pedicels being a light cinnamon-brown.

#### 8. PUCCINIA PAULENSIS Rangel.

On *Capsicum annuum* L. Collected by W. A. Kellerman at Antigua, Guatemala, Feb. 5, 1908. Nos. 7438 and 7104. Altitude 6,000 feet.

Aecia and telia covering large areas of stems, leaves and flowers, distorting the infected parts. (Host determined by Mr. Morton.)

The only other report of this rust is from Brazil (9). In fact none of the rusts of *Capsicum* have been reported outside of South America.

Averna (2, 3), who also worked in Brazil, seems to have been the first to record a rust on this host. In 1913 after considerable study of the fungus on several species of *Capsicum* he described it as a new "eu-form" of *Puccinia*, *P. Capsici*. In the Guatemalan material no pycnia or uredinia have been found and it seems to be a true "*Allopus*" rust as the teliospores often form within the old aecia. However in other respects it seems to agree in general with Averna's descriptions.

Mayor (8) published two new species, *P. Capsici* Mayor and *P. Gonzalezi* from leaves of *Capsicum*, on which only telia were present. Spore measurements given by him do not correspond with measurements of teliospores from the Guatemalan material.

Germano de Sousa (4) later published the results of some observations on a *Puccinia* affecting *Capsicum* and it seems likely that he was dealing with the same species as had been described by Averna.

Recently Kern and Whetzel (7) described the aecial stage of what they believed to be a new rust on *Capsicum*. Their description fits very well the aecial stage of the rust on the Guatemalan material.

With the possible exception of the species described by Mayor, these rusts of *Capsicum* are no doubt closely related. However, since no specimens other than those from Guatemala are avail-

able to the writer, it is impossible to determine the degree of relationship, and even if they were, it is quite likely that no definite conclusions could be made. It does seem that *Puccinia paulensis*, as considered here, is more widely distributed than previous records of its occurrence would indicate.

J. C. Arthur has examined a part of this material and believes it to be *P. paulensis* Rangel.

#### 9. PUCCINIA POROPHYLLI P. Henn.

On *Porophyllum* sp. Collected by W. A. Kellerman at Zacapa, Guatemala, Dec. 27, 1906. No. 6116.

This rust has not been reported from Guatemala before and the specimen here cited is of further interest because all four rust stages are represented. The pycnial and aecial stages have not been described and no reference is found to their ever having been observed. The pycnia occur in groups 1–2.5 mm. across on both surfaces of the leaf and are dark-brown. The small delicate aecia form usually on the under surface of the leaf in a circle about the pycnia. The material is hardly sufficient for a detailed description. Additional evidence is given by the fact that a specimen of *Porophyllum nummularium* DC. in the National Herbarium (No. 1168939) contains pycnia, aecia and telia of a rust which seems to be the same species. This latter specimen was collected at Gualan, Guatemala, by S. F. Blake, May 26, 1919.

#### 10. PUCCINIA JALISCANA Arth.

A specimen of this rust on *Porophyllum* in the Mycological Collections of the Bureau of Plant Industry (Holway No. 5130 from Mexico) contains a few pycnia and aecia in addition to the described spore stages. In general arrangement they are quite similar to those found associated with uredinia and telia of *P. Porophylli*.

#### 11. PUCCINIA BACCHARIDIS-MULTIFLORAE Diet. & Holw.

On *Baccharis Kellermanii* Greeman. Collected by W. A. Kellerman near Cerrito de Ori, Dept. Salada, Guatemala, Jan. 23, 1907. No. 6307.

This is the first report of a rust occurring on this host which was named in honor of Dr. Kellerman.

12. *PUCCINIA IRREGULARIS* Dietel.

On *Verbesina* sp. Collected by W. A. Kellerman at Volcano Imay, Guatemala, Jan. 8, 1908.

The rust has previously been reported only from Nicaragua.

13. *PUCCINIA EMILIAE* P. Henn.

On *Neurolaena lobata* (L.) R. Br. Collected by W. A. Kellerman at Morales, Dept. Isabal, Guatemala, March 9, 1907, No. 6316, and another specimen with only number and date, July 14, 1906, No. 5338.

This is a "*Micropuccinia*" which has not been reported from Guatemala before.

14. *DASYSPORA FOVEOLATA* (Schw.) Berk. & Curt.

On *Xylopia* sp. Collected by W. A. Kellerman at Morales, Guatemala, March 8, 1907.

There was also an abundance of the specimen cited by Arthur (1).

The host was not given on either of these specimens but the teliospores are so unusual in appearance that the rust is easily recognized.

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# THE CYTOLOGY OF A DIPLOID STERILE HYMENOMYCETE

J. E. SASS

(WITH 1 TEXT FIGURE)

In the normal nuclear cycle of a representative hymenomycete the fruiting mycelium and the fruit body, including the young hymenium, constitute the dikaryophase. During this phase the cells are binucleate, cell divisions are associated with conjugate mitoses, and at least in the vegetative mycelium clamp connections are present at the septa. The true diplophase, if we wish to make a distinction from the dikaryophase, is represented by the basidia following the fusion of the two nuclei in each basidium. Meiosis in the basidia and the subsequent formation of spores initiate the vegetative haplophase. In heterothallic species re-establishment of the dikaryophase is brought about by some form of conjugation between haploid mycelia.

Several distinct types of deviation from this generalized scheme are known. Haploid cycles which lack the binucleate and diploid condition have been described by Bauch (1), the present writer (7) and others. A number of observers have noted the occasional occurrence in nature, of sterile fruit bodies. This seems to occur in several genera of Agarics. Buller (2, 3) discusses the few cases recorded in the literature, and reports on additional observations made in his laboratory. The production of sterile fruit bodies in culture, on a haploid mycelium of a heterothallic species, has been reported by Kniep (5) for *Schizophyllum commune* and by Hanna (4) for *Coprinus lagopus*. Hanna found, however, that a clamp bearing diploid mycelium of *C. lagopus* may give rise to more or less sterile fruit bodies.

The present writer has made two collections of distinctly different sterile fruit bodies. One collection consisted of a caespitose group of plants, having filiform stalks .5 mm. thick and 3 cm. long, each bearing at its apex a slight swelling which did not

develop into a pileus. Attempts to isolate this fungus in pure culture were not successful.

On a collection of horse dung incubated in the laboratory, there appeared among the usual small *Coprini* a fruit body which at first was not distinguishable from the others, but presently proved to be sterile. The stipe elongated and the cap expanded in the normal manner, but the expected blackening and deliquescence did not occur. The gills were found to be practically without spores. A culture was made by dissecting the stipe and planting minute shreds of tissue on dung extract agar. The resulting mycelium was found to have clamp connections. A culture on sterilized horse dung produced abundant crops of sterile fruit bodies like the original collection.<sup>1</sup> The fungus resembles *Coprinus Boudieri*.

Because of the great scarcity of spores and the viscous nature of the mature gills, attempts to isolate spores have not been successful. The fungus has been carried in culture for five years by means of vegetative transfers. Clamp connections have persisted as a feature of the mycelium, and the cultures have produced only sterile fruit bodies. The production of fruit bodies is rather erratic. No attempts have been made to analyze the effect of physiological conditions on fruiting. Occasional cultures produce abundant crops of well developed, sterile fruit bodies.

Sectors differing slightly in appearance have appeared occasionally on the mycelium on agar plates. Isolations from the sectors have yielded only clamp-bearing mycelium, which produced only sterile fruit bodies. The possibility of significant changes in the character and fertility of the mycelium arising as sectors should not be ignored.

Cytological study of the hymenium showed that the young basidia are binucleate, and that nuclear fusion occurs in the

<sup>1</sup> Plant 5-10 cm. high. Pileus .8-1.5 cm. high before expansion, obtuse-campanulate; when expanded umbonate-plane, 1-2 cm. across. Margin plicate, surface *slightly pruinose*. Pileus at first brownish gray, darker on disk, becoming paler until it is nearly white, except the darker disk. Stipe 1-3 mm. thick, slightly tapering upward, white, silky striate, nearly smooth. Gills distant, occasionally forked, practically sterile, in the sense that very few basidia produce spores. Spores extremely rare, *keystone shaped*, 10-12  $\mu$   $\times$  6-8  $\mu$ , occurring in groups of 2, 3, or 4 on the basidia. After maximum expansion the fruit body collapses, but *autodigestion does not occur*. Fig. 1.

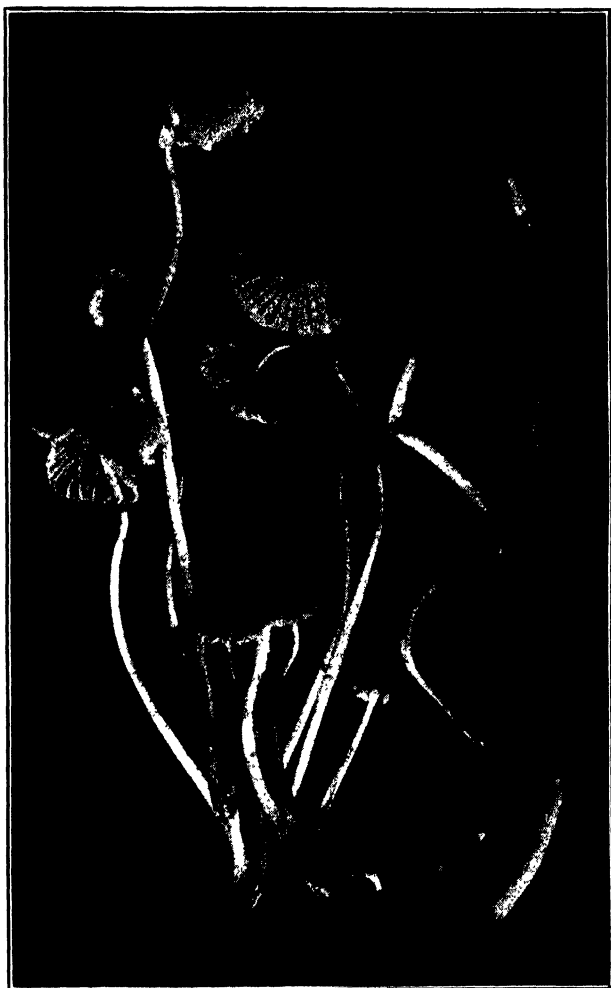


FIG. 1. The cytology of a diploid, sterile Hymenomycete.

basidia. These observations can be made with certainty, for the cells are still turgid at this stage, and good preparations can be made. As the pileus expands rapidly the gills become wrinkled, all the tissues become flaccid, and the basidia begin to collapse. It is difficult to make convincing preparations of subsequent stages. The almost complete absence of sporulating basidia reduces to the vanishing point the probability of observing their nuclear processes. Consequently, the cytology of the basidia



after karyogamy is uncertain. It is possible that most of the basidia do not develop beyond the fusion-nucleus stage.

Without single-spore cultures it cannot be stated whether this fungus is homothallic or heterothallic. Its diploid character is certain, as was shown by Hanna (4) to be the case in *Coprinus lagopus*. The remarkable viability of the culture and the constancy of the sterile character indicate that sterility is not necessarily caused, as Buller (3) suggested, by nutritional deficiencies. In view of the apparent failure of meiosis in the basidia, it is more probable that sterility is the result of this nuclear aberration. This situation is comparable to the failure of pollen formation in vegetatively normal, diploid flowering plants.

In view of our present knowledge of the cytology and sex reactions of haploid sterile and diploid sterile fruit bodies, it would be desirable to make further analyses of the reactions between haploid mycelia derived from haploid sterile, diploid sterile, and normal diploid fertile fruit bodies. The identity of the present fungus is too uncertain, and the degree of sterility too high to make further study profitable. The known occurrence of sterility in other genera of agarics affords attractive possibilities of further cytological and genetical studies on sterility.

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# PROMINENCE OF A CONIDIAL STAGE IN *PATELLA ABUNDANS*<sup>1</sup>

A. G. KEVORKIAN

(WITH 1 TEXT FIGURE)

## INTRODUCTION

In the family *Pezizaceae* conidial stages have been observed only rarely and within the many known genera have been reported only in *Aleuria* (7), *Pustularia* (1), *Plicaria* (1), *Peziza* (1), and *Pyronema* (6). Those produced in these genera alike bore hyaline ovoid conidia, on short sterigmata in heads characteristic of the *Oedocephalum* type of the imperfect fungi. In the genus *Patella*, however, in contrast to the preceding a *Botrytis* type of conidial fructification occurring on a variety of substrata in the vicinity of New York City has been reported for *Lachnea* (*Patella*) *abundans* by B. O. Dodge (2). Moreover, Gwynne-Vaughan and Williamson in London reported *Lachnea* (*Patella*) *cretea* (3), which has a similar conidial stage and indeed is considered as a synonym under *Lachnea* (*Patella*) *abundans* by Seaver. The writer, furthermore, has secured from a culture of horse dung from China a fungus identified by B. O. Dodge as *Lachnea* (*Patella*) *abundans* (Karst.) Sacc., and also a similar fungus in Rhode Island from a culture of a burnt stump. Both of these regularly produced a *Botrytis*-like conidial phase in abundance.

The fact that wherever this fungus has been reported, whether from New York, London, China, or Rhode Island, the typical *Botrytis* conidial stage has been found invariably to occur, would seem to indicate that this is a permanent phase and not a transient one induced by special nutrient and climatic conditions. It is the purpose of this paper, therefore, to present evidence supporting this view.

<sup>1</sup> Although *Lachnea* is the more widely known and universally used generic name, the writer prefers to use *Patella abundans* (Karst.) Seaver,<sup>4</sup> since *Lachnea* is in use as a valid genus of flowering plants and according to Article 65 of the International Code it is invalid as a cryptogamic genus.

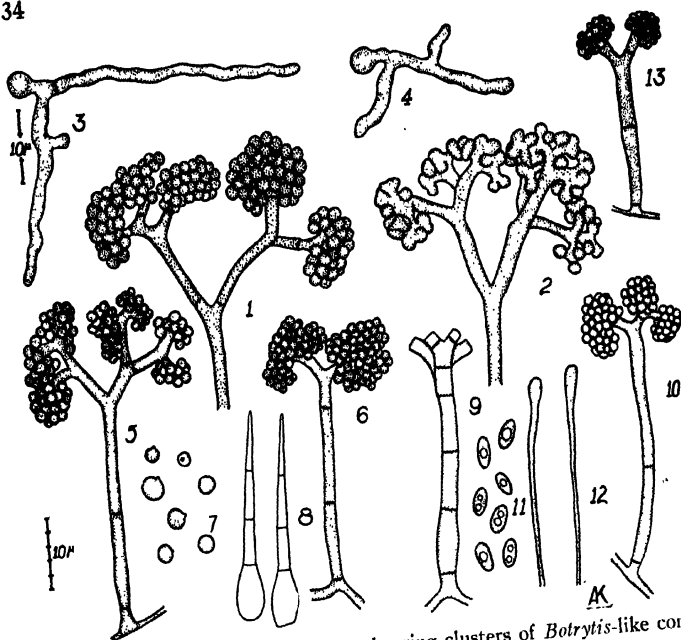


FIG. 1. (1) Typical conidiophore bearing clusters of *Botrytis*-like conidia on dichotomously branched conidiophores from material of the Chinese strain grown on 2 per cent potato dextrose agar ( $\times 200$ ); (2) Similar conidiophore, showing knob-like terminal enlargements before the development of conidia therefrom. Material from China grown on dung decoction agar ( $\times 200$ ); (3, 4) Two conidia from China strain germinating readily in sterilized tap water by means of thick branched germ tubes ( $\times 350$ ); (5) Conidiophore of China strain showing only slightly stunted habit, resulting from growth on tobacco ( $\times 200$ ); (6) Conidiophore of China strain showing stunted, sparsely branched condition typical of growth on tobacco ( $\times 200$ ); (7) Typical conidia, showing variation in size and shape, and the presence on same of a perceptible papilla of attachment. ( $\times 350$ ); (8) Setae, showing typical tapering form, bulbous base, and 3 septations ( $\times 350$ ); (9) Large conidiophore of the Rhode Island strain grown on tobacco showing the loss of the typical knob-shaped ends after the conidia have been scattered and the persistence of bases of secondary branches ( $\times 200$ ); (10) Conidiophore of Rhode Island strain grown on tobacco, partly matured, showing stunted, slightly branched habit typical of growth on this substratum ( $\times 200$ ); (11) Ascospores showing variation in size and shape and in number and position of oil droplets within the granular content ( $\times 350$ ); (12) Paraphyses, showing the typical swollen ends ( $\times 350$ ); (13) Very stunted conidiophore bearing few conidia. Rhode Island strain grown on tobacco ( $\times 200$ ). The drawings were made with the aid of a camera lucida, living material being mounted in Lacto-phenol-Carbol fuchsin, allowed to regain turgidity and then drawn. The magnifications apply to the present figures which have been reduced to approximately  $1/3$  diameter in reproduction. Scales in microns are included also for more accurate measurements.

## TYPICAL LIFE HISTORY

Both of these fungi, one isolated from horse dung from China, and the other developing on a burnt stump in Rhode Island, run through a life cycle comprising a *Botrytis*-like conidial stage followed by an apothecial stage which is typical of *Patella abundans*.

The conidia of these two forms, within 48 hours after planting, usually develop in *Botrytis*-like clusters (FIG. 1) on knob-like globular ends (FIG. 2) of branched conidiophores which in the China form are almost perfectly dichotomous and in the Rhode Island form are less so. At maturity the conidia (FIG. 7) are spherical to obovate, 7 to 9  $\mu$  in diameter, smooth, and with a papilla at the point of attachment.

The ascocarps of both organisms are discoid, slightly buff colored and about 1 to 3 mm. in diameter. The ascospores (FIG. 11) are 6 to 8  $\times$  12 to 16  $\mu$ , fusoid, 1 to 2 guttulate; borne uniseriately 8 in an ascus of about 150  $\mu$  in length. The paraphyses (FIG. 12) are about 150  $\mu$  long, enlarging abruptly at the ends to 4 to 5  $\mu$ . The hairs (FIG. 8) surrounding the ascocarp are buff to pale brown, several septate, tapering to a point.

It is evident that both forms are homothallic, for a single conidium, or a single ascospore may give rise to conidia and apothecia in each case.

## CULTURAL STUDIES

As Seaver (5) has enumerated a list of the substrata upon which the genus *Patella* has been reported, these were tested in order to determine the cultural requirements of the two fungi and to ascertain the presence or absence of conidial development under such conditions.

Table I gives in brief form the kinds of agars or substrata used, the type of spores sown, and the kind of growth and sporulation of the two organisms which resulted.

An examination of this table brings out certain points of interest. The conidial phase, for example, of both strains was always present on all media and substrata tried, showing that it is not an occasional but typical part of the life cycle, whereas the development of the ascogenous phase seemed to require special richly nutrient media such as oatmeal and potato-dextrose, its develop-

TABLE I

Substratum	Material Sown	Method of Growth	
		China Strain	Rhode Island Strain
Malt Agar	Conidia	Aerial mycelium and conidia very abundant growing on agar. Only one apothecium observed.	Aerial mycelium and conidia abundant, growing on agar and on sides of tube. Only a few apothecia observed.
Malt Agar	Ascospores	Aerial mycelium scarce, conidia very abundant, numerous apothecia, growth along edges of agar.	Aerial mycelium very scarce. Conidia very abundant. Apothecia produced in great abundance. Growth along side of tube.
Malt Agar	Abortive growth (conidia and hyphae)	Aerial mycelium in abundance. Conidia fairly abundant. Apothecia very small and scarce.	Aerial mycelium in abundance. Conidia abundant. No apothecia observed.
Malt Agar	Abortive growth	Aerial mycelium very scarce. Conidia abundant. Apothecia small but abundant.	Aerial mycelium very scarce. Conidia abundant. Apothecia small but abundant.
Oatmeal Agar	Ascospores	Aerial mycelium lacking. Conidia and apothecia produced on tube. Abortive apothecia produced on agar.	Aerial mycelium slight. Conidial and apothecial growth fair. Hyphal and conidial mass produced in a clump. No aborted apothecia observed.
Potato Dextrose Agar	Conidia	Aerial mycelium scarce. Conidia and apothecia rather scarce, produced on glass. Abortive apothecia on agar.	Aerial mycelium very abundant, conidia scarce. Apothecia none. Growth on agar.
Potato-plaster <sup>1</sup> Agar	Conidia	Aerial mycelium very scarce. Conidia formed on surface of agar. No apothecia formed.	Aerial mycelium very scarce. Conidia formed on surface of agar. No apothecia formed.
Soil	Conidia	Aerial mycelium scarce, conidia rather scarce, produced on surface of soil and on sides of flask. Apothecia scarce.	Aerial mycelium scarce. Conidia very abundant than in China strain.
Cinders <sup>2</sup>	Conidia	Aerial mycelium scarce, conidia very scarce. Only two apothecia found.	Aerial mycelium scarce. Conidia very scarce. No apothecia observed.

<sup>1</sup> Small clumps of ceiling plaster added to ordinary potato agar.<sup>2</sup> Furnace cinders, sterilized.

TABLE I—Continued

Substratum	Material Sown	Method of Growth	
		China Strain	Rhode Island Strain
Clumps of Plaster	Conidia	Aerial mycelium slight. Conidia very abundant on surface of substrate. No apothecia observed even after two months.	Aerial mycelium scarce. Conidia fairly abundant. No apothecia observed even after two months.
Dried Autumn Leaves	Conidia	Aerial mycelium in abundance. Conidia very abundant. Numerous apothecia.	Aerial mycelium in abundance. Conidia very abundant. Apothecia scarce.
Paper	Apothecium	Aerial mycelium in abundance. Conidia abundant. Numerous apothecia.	Aerial mycelium in abundance. Conidia scarce. Two apothecia observed.
Decayed Wood	Conidia	Aerial mycelium rather abundant. Conidia very scarce. No apothecia observed.	Aerial mycelium in abundance. Conidia scarce. No apothecia observed.
Ashes	Apothecium	Aerial mycelium fairly abundant. Conidia produced abundantly. Appearing grayish in mass instead of the typical pale buff color on agar. No apothecia observed.	Aerial mycelium fairly abundant. Conidia produced abundantly. Appearing grayish in mass instead of the typical pale buff color on agar. No apothecia observed.
Tobacco <sup>3</sup>	Apothecium	Aerial mycelium in abundance. Conidia very abundant, with short, thick conidiophores, usually not branched as much as those on agar. Abortive apothecia that do not mature, observed.	Aerial mycelium in abundance. Conidia very abundant, with short, thick conidiophores, usually not branched as much as those on agar. Abortive apothecia that do not mature, observed.
Potato Dextrose Agar	Conidia from Tobacco Culture	Aerial mycelium in abundance. Conidia scarce. Apothecia abundant, some twice as large and lighter in color than others.	Aerial mycelium in abundance. Conidia scarce, produced on glass. Apothecia abundant and normal, produced on glass and agar.

<sup>3</sup> Cigarette tobacco, sterilized.

ment being inhibited on such non-nutrient or scanty nutrient substrata as plaster, wood, ashes and tobacco. Another point of interest is the fact that two fungi from such widely different sources, in general grew in the same manner. Moreover, the appearance of conidia and ascocarps of the China organism always preceded that of the Rhode Island strain by 2 to 8 days on each substratum, showing its characteristically more rapid development.

Since the cultural differences are slight, as has been noted above, it seemed desirable next to compare the spore measurements of the two fungi. In Table II the sizes of spores grown on potato dextrose agar under approximately identical conditions, and mounted in Amann's Medium in the same way, were compared for the two fungi.

TABLE II  
COMPARATIVE SPORE MEASUREMENTS

Ascospores Length Classes in Microns	China Strain No. of Spores in 100	Rhode Island Strain No. of Spores in 100
10-11.9 $\mu$	5	1
12-13.9 $\mu$	77	47
14-15.9 $\mu$	17	49
16-17.9 $\mu$	1	3
Width Classes in Microns		
4-5.9 $\mu$	3	0
6-7.9 $\mu$	75	33
8-9.9 $\mu$	22	67
Conidia Diameter Classes in Microns		
6-6.9 $\mu$	10	18
7-7.9 $\mu$	48	45
8-8.9 $\mu$	37	32
9-9.9 $\mu$	0	5
10-10.9 $\mu$	5	0

It is obvious that in respect to size of spores there is little, if any, difference between the two organisms. Since the kind of growth and sporulation are so similar, and since the two forms are homothallic, a single ascospore or conidium giving rise to ascocarps, the writer is inclined to believe that the two are different strains of the same species.

It is of interest therefore that the two fungi derived from such widely separated localities as China and Rhode Island alike

should develop a well defined *Botrytis*-like conidial phase with such persistence and regularity.

The writer takes pleasure in acknowledging his indebtedness to Prof. W. H. Weston Jr., at whose suggestion this research was undertaken, for the helpful criticism during the investigation and also for the material from China.

#### SUMMARY

1. The development in culture, the method of growth, and sizes of the spores of two similar forms of *Patella abundans*, one derived from China, the other from Rhode Island, were compared and found to be practically identical.

2. This species therefore is inferred to be of wider distribution than has been supposed.

3. A *Botrytis*-like conidial stage is a definite, persistent, well defined characteristic developmental phase in the life history of this organism. This augments and corroborates the findings of B. O. Dodge in the case of this species in New York.

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## NEW FUNGI FROM ISLE ROYALE

ALFRED H. W. POVAH

(WITH 2 TEXT FIGURES)

During the summer of 1930 the writer spent three months on Isle Royale in Lake Superior as a member of the Botanical Party of the Survey of Isle Royale conducted by the State of Michigan under the auspices of the University of Michigan. The complete list of species is to be published later. In a collection of fungi numbering approximately eleven hundred collections the following fungi are believed to be undescribed. The specimens have been deposited in the University of Michigan Herbarium, with duplicates in the author's herbarium.

### *Patella michiganensis* sp. nov.

Apothecia gregarious, ochraceous-orange to cinnamon (R.), 0.3-0.7 mm. in diameter; clothed with simple, septate, brown hairs,  $300-900 \times 30-50 \mu$ , those hairs near the margin of the apothecium with an enlarged and often forked base, those hairs lower down on the apothecium with a tapering base; asci cylindrical  $180-200 \times 9-10 \mu$ , not staining blue with iodine, 8-spored; spores uniseriate, smooth, hyaline, elliptical,  $13.5-15.5 \times 8.5-9 \mu$ ; paraphyses slender, clavate at the tip where the diameter is  $5.5 \mu$ .

Apothecia gregaria, aurantia vel cinnamomea, 0.3-0.7 mm. diam., septatis fulvisve setis vestita  $300-900 \times 30-50 \mu$ , eis margine dilatatis et saepe furcatis ad basem, eis inferioris simplicibus et non dilatatis. Asci cylindranei  $180-200 \times 9-10 \mu$ , 8-sporei. J—. Sporae leves, hyalinae, ellipsoideae,  $13.5-15.5 \times 8.5-9 \mu$ , monostichae. Paraphyses filiformes, apice clavatae  $5.5 \mu$  cr.

Collected on July 16, 1930, by A. H. Povah on moose dung at Moose Lake, Tobin Harbor, Isle Royale, Michigan. No. Fp 211. Type in the University of Michigan Herbarium with duplicate in the author's herbarium.

This species differs from *Patella maculosa* (Phill.) Seaver in not

having brown spots on the apothecium; in possessing stiff, sharp-pointed hairs, rather than flexuous, blunt hairs; in the somewhat larger spores and the paraphyses being swollen at the tip.

The species was also collected on the Sargent Lake Trail, McCargoe Cove and at Tobin Harbor by J. L. Lowe and A. H. Povah.

***Erinella borealis* sp. nov.**

Apothecia gregarious, 0.3–0.7 mm. in diameter, short-stipitate, hymenium buff yellow (R.), externally white and covered with delicate, hyaline hairs; asci clavate  $98\text{--}105 \times 8\text{--}8.5 \mu$ , 8-spored;

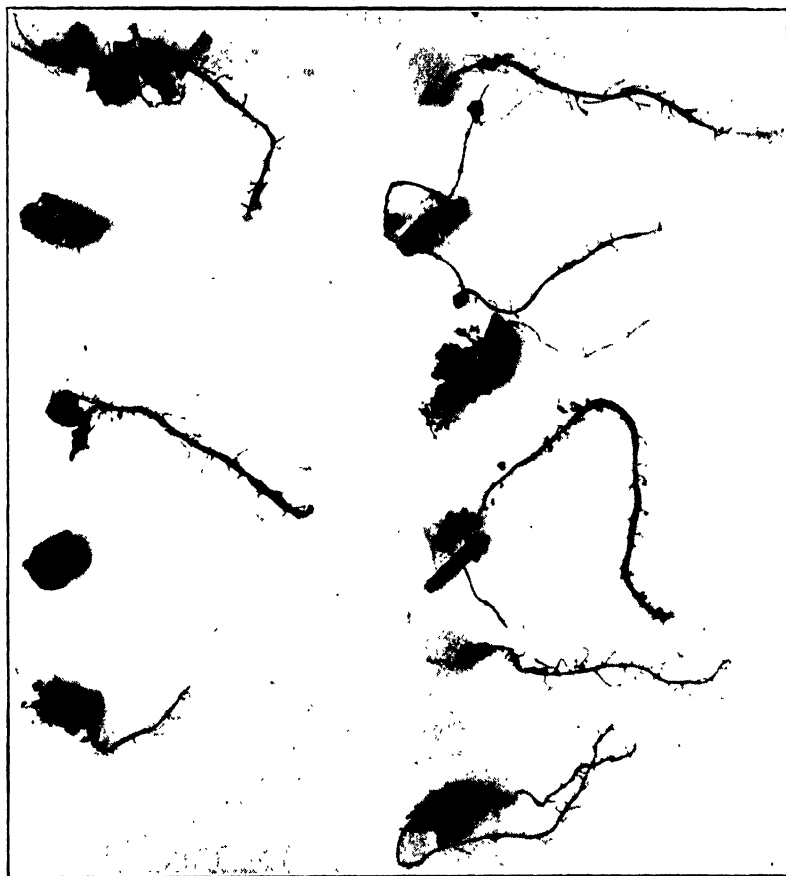


FIG. 1. Portion of type collection of *Sclerostilbum septentrionale* ( $\times 2.5$ ), showing sclerotia with racemously branched coremia attached.

spores fasciculate, filiform-fusiform, somewhat sigmoid, hyaline,  $33-58 \times 1.5-2 \mu$ , becoming triseptate; paraphyses filiform,  $1 \mu$  in diameter, but slightly enlarged at the apex.

Apothecia gregaria, aurantia vel cinnamomea, 0.3–0.7 mm. diam., brevistipitata, disco luteo, extus albis pilis vestita. Asci clavati  $98-105 \times 8-8.5 \mu$ , 8-spори. Sporae filiformes-fusiformes, rectae vel subcurvatae, 3-septatae, hyalinae,  $33-58 \times 1.5-2 \mu$ , fasciculatae. Paraphyses filiformes,  $1 \mu$  cr. apice minimum latior.

Collected August 14, 1930, on dead stems of *Chamaedaphne calyculata* in swamp of *Thuja occidentalis*, Rock Harbor, Isle Royale, Michigan, by A. H. Povah. No. Fp 497. Type in the University of Michigan Herbarium with duplicate in the author's herbarium.

### **Sclerostilbum** gen. nov.

Coremium arising from a sclerotium, with a sterile central axis; lateral branches usually terminating in a depressed-globose head bearing conidia; conidiophores branched; conidia in chains.

Coremiis racemis, ex sclerotio, sterile apice, ramis lateralibus semper ferme cum subgloboso capitulo conidia ferenti; conidiophoris ramificatis; conidiis in catenis.

Type species, *Sclerostilbum septentrionale*.

The genus resembles *Stilbothamium* superficially but differs in the presence of a sclerotium and catenulate spores.

### **Sclerostilbum septentrionale** sp. nov. (FIGS. 1, 2.)

Coremium 6–35 mm. tall, arising from a brownish-black sclerotium, central axis  $200-500 \mu$  in diameter, bearing 30–50 short lateral branches and thus forming a raceme; central axis ending in a sterile tip, lateral branches 0.5–2 mm. long,  $100-250 \mu$  in diameter, usually ending in a depressed-globose head  $125-370 \mu$  broad, but occasionally sterile; conidiophores branched; conidia in chains, hyaline, elliptical,  $7-12.5 \times 4-5.5 \mu$ .

Coremiis 6–35 mm. longis,  $200-500 \mu$  crassis, ex sclerotio, 30–50 brevibus, lateralibus ramis in racemo; medio axe apice sterile; lateralibus ramis 0.5–2 mm. longis,  $100-250 \mu$  cr. semper ferme cum subglobosa capitulo  $125-370 \mu$  crasso; conidiophoriis ramificatis; conidiis ellipticis,  $7-12.5 \times 4-5.5 \mu$ , hyalinis, catenulatis.

Collected on September 7, 1930, among decaying leaves beside brook forming outlet to Chickenbone Lake, McCargoe Cove, Isle Royale, Michigan, by A. H. Povah. No. Fp 440. Type in the University of Michigan Herbarium with duplicate in the author's herbarium.

That the present fungus may be the imperfect stage of a species of *Xylaria* is suggested by Moeller's<sup>1</sup> illustration. The writer

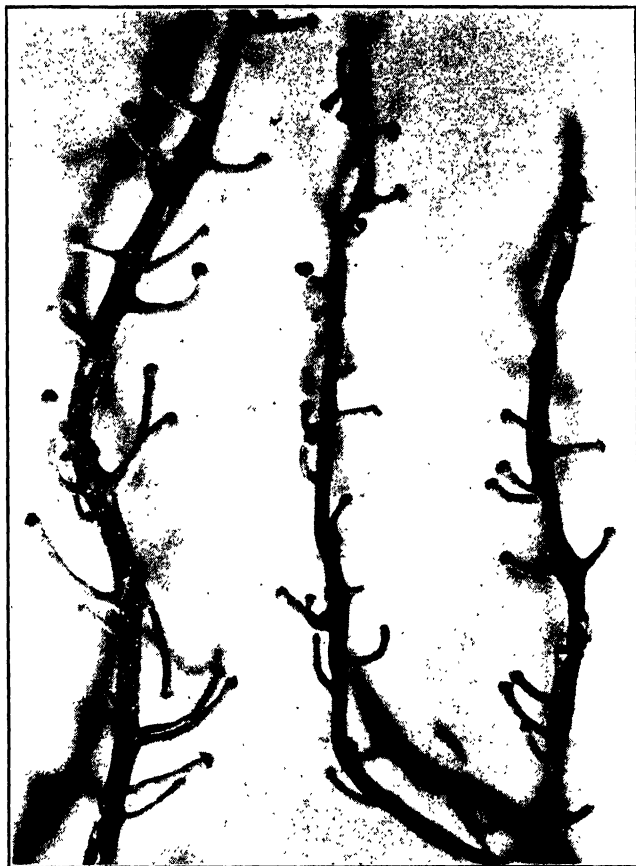


Fig. 2. Portion of type of *Sclerostilbum septentrionale* ( $\times 15$ ).

is indebted to Dr. Thaxter for showing him an undescribed species of *Xylaria* arising from a sclerotium which he collected in Maine.

<sup>1</sup> Moeller, Alfred, 1901. Phycomyceten und Ascomyceten. Untersuchungen aus Brasilien. Jena. p. 244.

**Septoria Calypsonis** sp. nov.

Pycnidia gregarious, on the upper surface of the leaves, minute, black, 82–115  $\mu$  in diameter, located in blackened areas 4–5 mm. in diameter or through confluence larger; spores filiform, hyaline, straight or curved, continuous, 28–48  $\times$  0.75–1.0  $\mu$ ; conidiophores short, unbranched.

Pycnidia gregaria, in foliorum superficie, minuta, atra, 82–115  $\mu$  diam., areia atris vel 4–5 mm. diam. vel confluentia maioribus disposita; sporidiis filiformibus, hyalinis, rectis curvatisve, continuatis, 28–48  $\times$  0.75–1  $\mu$ ; sporophoris brevis, simplicibus.

Parasitic on the leaves of *Calypso bulbosa*, Smithwick Island near Isle Royale, Michigan. Collected July 1, 1930. A. H. Povah. No. Fp 50. Type in the University of Michigan Herbarium with duplicate in the author's herbarium.

DETROIT, MICHIGAN

## NOTES AND BRIEF ARTICLES

Volume 7, Part 13 of North American Flora consisting of a host index of the Uredinales published in North American Flora was issued on December 30, 1931. This will be welcome to mycologists since it will make the volume much more usable.

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An oil portrait of Dr. J. C. Arthur was unveiled in the Agricultural Experiment Station of Purdue University, Lafayette, Indiana, on Wednesday, October 7, with a brief address by one of his former students, Dr. D. T. MacDougal, of the Desert Laboratory, Tucson, Arizona. Dr. Arthur, now in his 82nd year, is actively engaged in preparing a manual of the rusts of the United States and Canada.—M. W. GARDNER.

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### STUDIES ON THE GENUS *PYTHIUM*

In this book by Velma Dare Matthews an attempt is made to give descriptions to all the species of *Pythium* which had been discovered at the time of publication, and to report on twenty species which have been isolated by the writer. Of these, five are considered new. Keys are given to the genera of the family Pythiaceae and to the species of the genus *Pythium*. Several species are reported from the United States for the first time. There are twenty-nine plates. Twenty-six of these are from original drawings and three are copied from illustrations of species which the writer has not seen. There are 134 pages in all, nineteen of which are devoted to a bibliography. Published by The University of North Carolina Press. Price \$3.00 postpaid.

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### SPERMOGONIA OF *DIPLOCARPON ROSAE*

In discussing the life history of the rose black spot fungus in a recent paper (*Mycologia* 23: 446-462. 1931) I stated that no one had previously mentioned that this fungus produces spermo-

gonia. This was an oversight on my part as I now find that Dr. F. A. Wolf had already discovered these structures and mentioned them in his paper on "Leaf Scorch Disease of Strawberries" (North Carolina Agr. Exp. Station Tech. Bull. 28, 1926) where he points out that in their morphology and life history the strawberry leaf scorch fungus and the rose black spot fungus are very much alike. He has given several figures in support of his view. Spermogonia were very abundant on infected rose leaves which were still green in November in our rose garden.—B. O. DODGE.

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#### LABOULBENIACEAE

Part 5 of Dr. Roland Thaxter's work "Contribution towards a monograph of the Laboulbeniaceae" has recently been received. This is published as a Memoir of The American Academy of Arts and Sciences (Volume 16, Part 1). It was originally intended to include in this part all the forms published or assembled since the appearance of Parts 1 and 2 but it has been found necessary by Dr. Thaxter to leave out the largest genus *Laboulbenia*, which he hopes to publish at some later time. The present volume consists of 375 pages with 60 plates and 1136 figures. It considers 90 genera, many of them new, and is a continuation of Part IV of this series of Memoirs (Am. Acad. Vol. 15, pp. 430–580, Plates 1–24) in which 12 genera are considered including more than a hundred species of the very varied and remarkable genus *Rickia*. The plates are artistically done in his characteristic, careful and painstaking manner. The whole work is a most valuable contribution to our knowledge of the subject. It is to be hoped that Dr. Thaxter may finally complete the last part of this work.

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#### THE WINTER MEETING

The meeting of the Mycological Section of the Botanical Society of America held in New Orleans during the winter was well attended in spite of the fact that it was far from the center of the main mycological activities of the country. One session was arranged for mycological papers. The program, however, was overcrowded and might easily have furnished material for two sessions. The papers were interesting, but the time was too

brief for adequate discussion. One joint session was then held with the Phytopathological Society.

The most important transaction of the Mycological Section was the decision to establish an independent mycological society. Dr. William H. Weston Jr. of Harvard was appointed President and Dr. H. M. Fitzpatrick of Cornell Secretary. A committee of five, including the two officers, was appointed to draw up constitution and by-laws, arrange for summer forays, and consider the question of mycological publication, the committee to report at the first regular meeting to be held in Atlantic City in connection with the American Association for the Advancement of Science.

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#### NEW YORK MYCOLOGICAL SOCIETY

During the summer of 1931 the New York Mycological Society was reorganized with Dr. William S. Thomas, author of "Common Gilled Mushrooms," as President and Miss Margaret McKenny, author of "Mushrooms of Field and Wood," as Secretary. On October 26th, the newly formed Society in collaboration with the Torrey Botanical Club and The New York Botanical Garden gave a luncheon in the American Museum of Natural History in honor of Dr. Jakob E. Lange, the Danish expert on gill fungi, who had been spending the summer in the United States. Preceding the luncheon Dr. Lange made an exhibit of several hundred watercolored drawings of European gill-fungi. This exhibit was supplemented by a display of fresh material a study of which furnished for the local students of fungi a mycological "love feast." The meeting was attended by most of the local mycologists connected with the various institutions in and about New York City. Among the distinguished visitors from out of town was Mrs. Eliza Blackford, President of the Boston Mycological Club, an artist naturalist whose inspiring personality and unceasing efforts have kept the Boston organization in a flourishing condition for many years.

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#### THE C. G. LLOYD MYCOLOGICAL COLLECTION

The mycological collection of the late C. G. Lloyd of Cincinnati was donated by the trustees of the Lloyd Library and Museum



to the Smithsonian Institution and transferred to Washington where it was placed in the custody of the Bureau of Plant Industry. The collection totals nearly 60,000 specimens of fungi, 12,000 negatives, a considerable series of prepared slides, Mr. Lloyd's correspondence in part, his notebooks and various miscellaneous items. The fungi have been catalogued, relabelled and arranged so that the Lloyd Herbarium is now in working order. A complete alphabetical index has also been prepared. Under the terms of the agreement covering the transfer to the Smithsonian Institution, the specimens constituting the collection can not be sent out of Washington but are available for study by interested mycologists in the Division of Mycology and Disease Survey, of the Bureau of Plant Industry.

Among the materials in the collection are a number of sets of the photogravures of American fungi originally issued by Mr. Lloyd about thirty years ago. These sets as now constituted contain the original 26 numbers with the addition of six plates prepared by Mr. Lloyd but never distributed. These sets are offered as long as the supply lasts to Mycological herbaria or Botanical Institutions. The plates are sent out under the names used by Mr. Lloyd. Some of the numbers, including the six not previously issued, can also be supplied separately to permit the filling out of incomplete sets.

An index to Volume 7 of the Mycological Writings of C. G. Lloyd has been prepared by the custodian of the collection and published by the Lloyd Library. Copies will be sent on request.  
—JOHN A. STEVENSON.

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### THE GENERA OF FUNGI<sup>1</sup>

Interest, perhaps not unmixed with surprise, has doubtless greeted the recent appearance of "The Genera of Fungi" which seems to be a revision of the former work published by Clements in 1909 and largely a translation of Saccardo's keys, the new work being somewhat augmented and embellished with illustrations. While this is a tremendous undertaking and perhaps too "Herculean" a task to be satisfactorily executed by any one or any

<sup>1</sup> Frederick E. Clements and Cornelius L. Shear. *The Genera of the Fungi*. I-IV, 1-496, pls. 1-58. The H. W. Wilson Co., New York. 1931. Price \$8.00.

two men, however well versed in mycology, it is nevertheless difficult to account for the flagrant errors and incongruities with which the work literally abounds. The comments, however, which the writer has to make will be confined largely to the Pezizales and Hypocreales, on which he has done special work. It is hoped that the authors have been more successful in their disposition of the genera of other groups.

The treatment of the genera of the cup-fungi is to say the least a disappointment. In the first place the authors refuse to recognize the segregation of the cup-fungi into the inoperculates and operculates, since as stated by them "*it is considered to make an unnatural division of the phylum.*" Consequently they follow the old tradition, keeping the operculate *Helvellae* and inoperculate *Geoglossae* in the same family *Helvellaceae*, in the diagnosis of which they state (page 139) in referring to the asci "*opening by an operculum,*" apparently oblivious of the fact that the asci in more than half of the species of the genera included in the family by them **do not open in this manner at all** but are inoperculate.

Contrary to their statement, the division into the operculates and inoperculates is one feature in our classification of the cup-fungi which follows absolutely natural lines, whatever may be said for subsequent subdivisions, and is so regarded at the present time universally by morphologists and taxonomists of the group, so far as the writer is aware.<sup>2</sup> It would be just as logical to argue that the "monocots" should not be separated from the "dicots," regardless of their anatomical differences, since such a division would be unnatural in that it separates the palm trees from other trees which they remotely resemble in size and form. Having lightly ignored the fundamental basis of classification in cup-fungi we can scarcely expect a satisfactory treatment of the subordinate groups, and in fact the whole group becomes another "mycological omelet."

The characters on which the families of the cup-fungi are based are at best vague and unsatisfactory and in the main the authors have followed the usual procedure, except that the lichen genera have been interspersed with those of the other fungi which is in

<sup>2</sup> See Gmann, E. A. and Dodge, C. W. *Comparative Morphology of Fungi*, p. 317, 1928.

line with the modern trend. Some of the families, however, of the non-algiculus cup-fungi are open to question. The authors persist in segregating the Ascobolaceae from the Pezizaceae on the fimicolous habitat and the exertion of the ascus, notwithstanding the fact that the latter has long been known to be absolutely worthless as a diagnostic character. The exertion of the ascus is common in many species of the Pezizaceae and especially conspicuous in the genus *Lamprospora* (MYCOLOGIA 4: 47. 1912). The fimicolous habitat would be a convenient character on which to separate the Ascobolaceae were it not for the fact that a number of species of the genus *Ascobolus* reported from North America (7 out of 16 to be exact) are non-fimicole. It will be seen, therefore, that the characters used in segregating the Ascobolaceae are absolutely unreliable and the family cannot stand. While the other families in the main follow general usage one is frequently surprised to find familiar genera in the wrong family. One of these departures will be cited as an illustration.

The family Ascobolaceae which, as stated above, cannot be maintained on the characters used, is divided by the authors into two subfamilies based on the color of the spores, the Ascophanae with colorless spores and the Ascobolae with colored. They then follow Lindau (*E. & P. Nat. Pfl.* 1<sup>1</sup>: 191. 1897), in retaining the genus *Boudiera* in the violet spored section of the Ascobolaceae notwithstanding the fact that **the spores are never violet; plants non-fimicolous; neither do they have exerted asci** (so far as observed). In fact the genus has none of the characters which would qualify it for the family or subfamily in which it is placed by them. Unfortunately Lindau erroneously described the genus as having violet spores. The species from which Lindau's description was drawn was apparently not a *Boudiera* but possibly an *Ascodesmis*, since the two genera were confused by Lindau. The perpetuation of these errors is again inexcusable since all of the data have been published (MYCOLOGIA 6: 107. 1914), and the observations based not only on authentic material from Europe but on fresh material collected by the writer in Iowa. So far as known the genus has been found from only two localities in North America, and belongs with the Pezizaceae.

## GENERIC TYPES

One of the novel features of this work is the designating of the type species for all the recognized genera of the fungi. Perhaps the most novel thing of all is the easy method by which this is accomplished. To use the exact words of the authors "*the type species should be chosen from the best known or more important species generally included in the genus at present,*" which apparently means the species best known to the authors of this book. If they knew but one species in the genus that species would become the type regardless of the fact that the type may have been otherwise indicated not only by the author of the genus but by subsequent "revisionists." To use the authors' words again,—"*this in many cases necessitates the choice of a species not included by the original author of the genus.*" All this is done on the pretext of securing stability of nomenclature but in looking over this work we find that after reviling the "revisionists" for inaugurating changes on the basis of priority these "advocates of stability" at any cost proceed to beat the "revisionists" at their own game, ruthlessly overturning genera without the slightest regard to either priority or usage, unless their own work should be regarded as the "last word" in usage. Not only is this procedure inconsistent with the principles which they themselves advocate but it is absolutely contrary to the rules adopted at the last International Congress which The New York Botanical Garden now proposes to follow and which read as follows: (translated from the French) "XVIII quater. *When one makes a revision of a genus he shall indicate carefully the species which he accepts as the standard or nomenclatorial type.*" "Note. —*The type species is the original species or one of the original species on which the genus was based, the standard species is one of the original species other than the type, which permits the conservation of the generic name in its current application.*" In no case do these rules justify the selection as the type of the genus a species not originally included in it by its author although it does allow one to select some species other than the first one mentioned if by so doing we may preserve the present concept of the genus. A few illustrations will be cited from the Pezizales and Hypocreales in order to bring out the illegality and inconsistencies in the authors' method of procedure:

1. In looking over the genera of the Pezizaceae in Clements and Shear one will note that the genus *Discina* Fries is typified by the species *Peziza venosa* Pers. Now, when this genus was founded by Fries (*Summa Veg. Scand.*, 348. 1849), he based it on the species, *Discina perlata* Fries, characterized by its apiculate spores. When Saccardo took up this genus (*Syll. Fung.* 8: 99. 1889) the same species was mentioned first and therefore regarded as typical. When the writer monographed the genus in 1928 he followed the previous authors in using the same type. **Does this or does this not constitute general usage?** The authors apparently think not since they choose to disregard all this and select *Peziza venosa* as the type, a species not originally included in the genus and one not now nor then regarded as congeneric with Fries' type and which if accepted (of course it will not be) would make it a straight synonym of *Peziza* and necessitate a new name for those forms now placed in *Discina*.

2. Another example from the Pezizaceae might well be cited to illustrate Clements and Shear's method of stabilizing the nomenclature of the cup-fungi. It has long been known that the name *Lachnea* is untenable<sup>3</sup> as a generic name in the cup-fungi since it had previously been used for a genus of flowering plants. **On this point the authors and writer are agreed.** The writer, recognizing this fact, reluctantly replaced the old name *Lachnea* with and prior name *Patella* of Weber and transferred all the members of this genus to that name (*North American Cup-fungi*, 156. 1928). This name was selected in accordance with the rules of the American Code of Nomenclature, which rules the authors of this book helped to formulate. The authors of the new work, however, through oversight or otherwise, have failed to accept the substitution of this name but have preferred to adopt instead the later name *Scutellinia*, first used by Cooke as a subgenus and later raised to generic rank by Otto Kuntze but erroneously assigned to Cooke by Clements and Shear. This

<sup>3</sup> International Code, Art. 65 (vide former Art. 27, 29, 51: 20, 53). "A name of a taxonomic group is illegitimate and must be rejected if it is a later homonym, that is if it duplicates a name previously and validly published for a group of the same rank based on a different type. Even if the earlier homonym is illegitimate, or is generally treated as a synonym on taxonomic grounds, the later homonym must be rejected."

name is not tenable under either the American or the International Code of Nomenclature. If their suggestion is followed it will necessitate another overturning of the genus *Patella* and a new set of combinations for more than half the species of the genus. Furthermore, since *Lachnea* cannot be retained as a generic name in the fungi to select *Scutellinia* instead of the prior name *Patella* is neither in accordance with the rule of priority nor their own suggestions (page 16) "that each name proposed be short, significant, euphonious," etc. Since *Patella* is not even cited as a synonym, the writer would be inclined to regard this as an oversight, were it not for the fact that the work in which this appears is cited in their bibliography. If on the other hand they chose to ignore these facts, the writer has a perfect right to charge them with insincerity in their feigned efforts to cooperate in stabilizing the nomenclature of the cup-fungi for they have, after again disregarding both priority and usage, committed the very offense with which they so often charge the "revisionists."

3. Still another illustration might be drawn from the cup-fungi. The genus *Bulgaria* was established by Fries (*Syst. Myc.* 2: 166. 1822) and two widely known species included in the genus. The first of these was *Bulgaria globosa*, a terricolous species with an operculate ascus and hyaline spores. The other, *Bulgaria inquinans*, is a lignicolous species with inoperculate ascus and brown spores. For some time it has been known that these species are not congeneric and efforts have been made to separate them, but so far as general usage is concerned both have continued to be recognized as *Bulgaria* (*Sacc. Syll. Fung.* 8: 636-637. 1889). Since the former is one of the operculates it was treated by the writer (*North American Cup-fungi*, 194. 1928) under the name *Bulgaria* with *Sarcosoma* Casp. as a synonym. *Bulgaria globosa* was designated the type of the genus.

The writer in his forthcoming monograph is then proposing the name **Phaeobulgaria** nom. nov. with *Peziza polymorpha* Oeder (*Peziza inquinans* Pers.) as the type, which is to be used for the lignicolous brown spored inoperculate species which, in the opinion of the writer, belongs with the Dermateaceae. Clements and Shear as usual disregard this treatment and reverse the situation making *Peziza inquinans* the type of the genus *Bulgaria*.

In this case there is less confusion since so few species are involved but inasmuch as the genus had already been monographed and the type designated in accordance with the rules of the International Code it should be allowed to stand unless valid reasons, other than mere personal preference, can be advanced for reversing this decision.

4. One of the most interesting cases of "sleight of hand" work in the selection of types is to be found in the case of *Lachnella* (page 327). This genus was established by Fries (*Summa Veg. Scand.*, 365. 1849) and six species enumerated. Boudier found that the sixth species was an operculate and not congeneric with the other five mentioned by Fries all of which are inoperculates. He therefore made this the type of a new genus *Perrotia* (*Bull. Soc. Myc. Fr.* 17: 24. 1901). This genus has been recognized as valid by students of cup-fungi and has already been treated among the operculates (*North American Cup-fungi* 154. 1928). That Clements and Shear should have skipped over five eligible species and selected the sixth one as the type of *Lachnella*, knowing that it was already the type of another genus recognized by critical students as valid, is directly contrary to their own suggestion to follow current usage and is one of the mysteries in connection with their method or lack of method in selecting types which the writer has been unable to solve. Other illustrations are taken from the Hypocreales as follows:

5. The subgenus *Peckiella* was founded by Saccardo (*Syll. Fung.* 2: 472. 1883) on *Sphaeria viridis* Albert. & Schw. and later raised to generic rank by Saccardo himself (*Syll. Fung.* 9: 944. 1891). When a subgenus is raised to generic rank it is customary and logical to select the type of the subgenus as the type of the genus unless otherwise specified. At that time (1891) a number of additional species were added including *Peckiella xylophila*. According to custom the writer, in his monograph of North American Hypocreales, selected *Sphaeria viridis* as the type of the genus *Peckiella* which is distinguished from *Hypomyces* by its non-septate spores. For more than twenty years this has stood as the type of the genus in North American literature (*MYCOLOGIA* 2: 67. 1910; *North American Flora* 3: 39. 1910). In spite of these facts, however, Clements and Shear select *Hypomyces xy-*

*lophilus* Peck as the type of the genus. This species was known only from the type locality in Ohio and the writer has in his possession material which is either type or cotype. As already indicated (MYCOLOGIA 2: 73. 1910) this specimen is so fragmentary that it is difficult to determine its identity from spore characters. So far as we can judge, however, on its general appearance it is a poor specimen of *Hypomyces apiculatus* and not a *Peckiella* at all. Even if it were a *Peckiella*, to select a species which is practically unknown as the type of this genus in preference to the well known, widely distributed *Sphaeria viridis*, parasitic on species of *Russula* and *Lactaria*, on which the subgenus was based by Saccardo and already repeatedly designated as type of the genus is **not only illogical and illegal but not even consistent with their own suggestion**: "*the type species should be chosen from the best known or more important species generally included in the genus at present.*"

From the above it is apparent that types are selected "without rule or reason." And yet the authors state (page 15) that the International Commission "*recommends this method of fixing generic types.*" If so why have rules? Especially to be deplored is the utter disregard of the work of others. Many more cases might be cited but these will serve to show the utter lack of method and irresponsible manner in which types were selected.

#### MISLEADING CITATIONS

Another practice which should be severely criticized is incorrect citations of genera, *i.e.* *Otidea* and *Geopyxis* to Persoon; and *Acetabula*, *Dasyscypha*, *Humaria*, *Mollisia* and *Phialea* to Fries, who never used them as generic names, and such names as *Galactinia*, *Scutellinia* and *Sepultaria* to Cooke who used them as subgeneric names only. The above are only a few of the many illustrations that might be cited. Such practice is not only incorrect and illegal but leads to much confusion.

#### CHANGES IN SPELLING

While the authors of this work are (avowedly) opposed to any change in generic names, they are apparently not averse to changes in spelling of those names, *i.e.* provided those changes



are inaugurated by them. Clements and Shear (page 328) refuse to recognize the substitution of *Humarina*, by the writer, for *Humaria*, of Saccardo (1889), **which name had been previously used by Fuckel in an entirely different sense**, since this substitution would necessitate the addition of one letter "n" to the name and would therefore be a violation of the sacred law of "usage" which they claim to be following. These same authors, however, seem to have no pangs of conscience in changing the old, widely recognized names *Lycoperdon* of Linnaeus (1753) and *Hypoxylon* of Bulliard (1791) to *Lycoperdum* and *Hypoxylum* of Clements (1909) and for no reason except personal preference. Is the **recent, untenable, little-known** name *Humaria* any more sacred to mycologists from the standpoint of "usage" than the **old, perfectly tenable, widely-recognized** names *Lycoperdon* and *Hypoxylon*? Or does it make a difference who suggests the change? There are many other diversions from the original spelling, such as *Exoascus* to *Exascus*; *Gelatinosporium* to *Gelatinosporis*. (In the latter case, not only was the name mutilated but the wrong species was designated as the type and page citation incorrect.) Of course these changes are unjustifiable under the rules but what do these authors care for rules? Are they not a law unto themselves?

#### SYNONYMS

The attempt of Clements and Shear to work out the synonymy of the genera of the cup-fungi on a literary basis, *i.e.* without any knowledge of the plants themselves has resulted in some ridiculous combinations. One or two of these will be cited.

1. The genus *Catinella* Boud. is made a synonym of the genus *Aleurina* Sacc. (page 327). The former is an inoperculate species occurring on rotten wood and of a semi-xerophytic consistency, and with minute, smooth spores which at maturity are colored. The latter is a large fleshy cup-fungus occurring on the ground and with an operculate ascus, large reticulated, colored spores. The fact that one is operculate and the other inoperculate would of course have no weight with Clements and Shear, since they do not regard this character as having any taxonomic value. But, even leaving this character out of consideration, the two genera have absolutely nothing in common except that the spores

in both are colored and even this means nothing since *Catinella* has green spores and *Aleurina* brown. It is quite evident that the authors of this book had no first-hand knowledge of either genus.

2. Equally unwarranted is the reduction of the writer's genus *Pseudopithyella* to *Sarcoscypha*. If *Pseudopithyella* were to be reduced at all it should be made a synonym of *Iiumaria* as treated by Clements and Shear. It might be defined as a *Iiumaria* with a collared ascus just as *Streptotheca* is a *Rhyparobius* with a collared ascus. If the presence of a collar near the end of the ascus is a valid generic character in the one case it is equally valid in the other. Of course this reduction is again purely academic since evidently neither author had seen material.

3. It is again noted (page 329) that Clements and Shear have made *Melastiza* Boudier a synonym of their genus *Scutellinia* (*Patella* Weber). This species was founded by Boudier on the reticulate spored form, *Peziza miniata*. Just why this genus should have been reduced to synonymy is not apparent, since it was founded on a very good character, the same character in fact on which *Aleuria* was segregated from *Peziza*. Since the authors recognize the reticulate character of the spore as a valid one in the latter we fail to understand why they should disregard it in the case of *Melastiza*.

4. Another illustration is the reduction of the tropical genus *Cookeina* which is made a synonym of *Sarcoscypha* as treated by Clements and Shear (*Plectania* Fuckel as treated in North American Cup-fungi, 190. 1928). The genus *Cookeina* is made up of strictly tropical species characterized by their fasciculate hairs and striate spores, while the other genus *Sarcoscypha* (*Plectania*) is made up of strictly temperate species with non-striate spores and non-fasciculate hairs. While the two genera have a superficial resemblance in form and color I am sure that no one who had any critical knowledge of the species involved would treat them as synonyms. One or two other illustrations might be drawn from the treatment of the genera of the Hypocreales:

5. The genus *Nectriella* was founded by Nitschke and described by Fuckel (*Symb. Myc.*, 175. 1869). The genus was distinguished from *Hyponectria* by possessing 1-septate spores. Sac-

cardo later described the genus *Charonectria* (*Michelia* 2: 72. 1880) based on exactly the same characters. In the monograph of the Hypocreales of North America (*MYCOLOGIA* 1: 45. 1909 and *North American Flora* 3: 4. 1910) *Nectriella* was regarded by the writer as the valid name while *Charonectria* Saccardo was treated as a synonym based on the rule of priority. Clements and Shear, however, again reverse the situation disregarding both priority and usage and make *Charonectria* the valid name while *Nectriella* Nitsch. is regarded as a synonym. This seems to be in keeping with their general rule to do something different from that which had been done by their predecessors, another contribution to the stabilizing of the nomenclature of the Hypocreales.

6. *Clintoniella* was founded by Saccardo (*Syll. Fung.* 2: 532. 1883) on *Hypocrea apiculata* Cooke & Peck. After examining specimens of this species determined by Peck the writer became convinced that it was not a *Hypocrea* but a *Hypomyces*. The matter was taken up with Dr. Peck in 1907 and in reply to inquiries Dr. Peck states after examining type material of *Hypocrea apiculata* the following: "This is not a *Hypocrea* as reported but a *Hypomyces*. The generic distinctions then were not quite as clear as now." On the strength of this report *Clintoniella* which was based on this species was in the monograph of the North American Hypocreales made a synonym of *Hypomyces* and the type species described under that generic name. Clements and Shear, however, again reverse the decision and make *Clintoniella* a synonym of *Hypocrea*. This procedure is absolutely inexcusable inasmuch as all of these facts were published (*MYCOLOGIA* 2: 74. 1910). Whether the authors of this work were guilty of gross negligence in failing to note these facts or otherwise the reader may judge for himself.

7. *Chromocrea* was founded by the writer (*MYCOLOGIA* 2: 58) on *Hypocrea gelatinosa* and distinguished from *Hypocrea* by its colored spores. Clements and Shear make both this genus and one of the two genera, *Chromocreopsis*, mentioned below synonyms of *Pheocreopsis* Sacc. & Sydow. Possibly one of the genera might be a synonym of the above genus but since *Chromocrea* has a sixteen spored ascus and *Chromocreopsis* an eight spored

ascus they could not both be synonyms of the same genus, unless the authors choose to disregard the number of spores in the ascus as a generic distinction. If this attitude is taken, however, there is no reason for separating *Hypocrea* and *Hypomyces* since they are distinguished on exactly the same characters. To be sure the authors in their key describe the perithecia of *Hypomyces* as occurring on a subicle while the perithecia of *Hypocrea* occur on a stroma but would the authors please tell us what is the difference between a subicle and a stroma? If the presence or absence of a stroma is of no generic importance in separating *Nectria* and *Creonectria*, how can it be of any importance in separating *Hypocrea* and *Hypomyces*? That this distinction is not adhered to by them is evident by the fact that *Hypomyces apiculatus* in which the perithecia occur on the subicle is placed in the genus *Hypocrea* which according to them is supposed to have a stroma although it does not rightfully belong there. Furthermore *Hypocrea sulphurea* (possibly the authors were not familiar with this species) has a subicle or stroma exactly like that of a *Hypomyces* so the only certain character left on which *Hypomyces* can be distinguished from *Hypocrea* is in the number and character of the spores. They cannot therefore consistently make *Chromocrea* and *Chromocreopsis* synonyms of the same genus if, indeed, either one of them is a synonym at all. This point cannot be determined definitely for lack of suitable material.

#### NOMENCLATORIAL BUNGLES

Some of the anomalies in this volume can be explained only under the head of just plain bungles. One or two of these will be cited to illustrate the slipshod manner in which genera have been literally mangled.

##### A. TWO GENERA BY THE SAME NAME

1. On page 114 of this work the genus *Urnula* as represented by *Urnula Craterium*, the commonly known black "urn fungus," is placed in the family Dermateaceae and there stands out "like a sore thumb" as the only operculate genus in a family where all the other members are inoperculate. On page 138 another genus *Urnula* as represented by *Urnula terrestris* (which is the

type of *Podophacidium* Niessl) is placed in the family Pezizaceae. This is equally out of place since it is inoperculate and the family Pezizaceae is characterized by the presence of an operculum as stated by the authors themselves (page 12). Then (page 313) the *Urnula* (*Podophacidium*) as represented by *Urnula terrestris* is made a synonym of *Urnula* as represented by *Urnula Craterium*. Thus we have two genera by the same name *Urnula*, both cited to the same author (Fries), but each characterized by a different species (one operculate and the other inoperculate), each placed in a different family (the inoperculate in the operculate family and the operculate in the inoperculate family) and finally the two cited as synonyms of each other. Just how may I ask the authors can these things be? **How can two genera have the same name, and if they belong to different families how can they be synonyms the one of the other?**

2. Again, the genus *Chromocreopsis* was founded by the writer (MYCOLOGIA 2: 63. 1910) and the type designated as *Chromocreopsis cubispora* Ellis & Holway. In 1915 the writer named a new species *Chromocreopsis striispora* for John A. Stevenson, then of Porto Rico, which was later published (*Jour. Dept. Agr.* 1: 213. 1917). Clements and Shear in recording *Chromocreopsis* erroneously assign it to Stevenson in 1917 although he had nothing to do with the founding of the genus which was described by the writer seven years earlier. They then made *Chromocreopsis striispora* Stevens the type although this species was not even known when the genus was founded. *Chromocreopsis* is then made a synonym of *Sarcoxyllum* Cooke (originally *Sarcoxyylon*), a genus which was described by Cooke in 1883 but has not been in use as a valid genus since that time. So far as we can judge from the descriptions, the genera are in no sense synonymous and even if they were why on the basis of "usage" should these authors dig up a name which has never been used as a valid genus by Saccardo or Engler & Prantl to replace *Chromocreopsis* which has stood in North American literature for more than twenty years. **Is this consistent with their avowed purpose to disregard priority in favor of usage in order to avoid change?** To make matters worse the second genus by the same name assigned to the writer (Seaver) and typified by *Hypocrea cubi-*

*spora* was listed and then made a synonym of *Phaeocreopsis* Sacc. & Sydow. Thus we again have records of two genera by the same name *Chromocreopsis*, assigned to different authors, typified by different species, and each made a synonym of a different genus (see p. 280 and 283). There never was but one genus *Chromocreopsis* and that was described by the writer as indicated above. **How could one genus possibly be a synonym of two different genera?** Just why a genus *Chromocreopsis* should have been attributed to Stevenson who had nothing to do with the genus other than to publish a species previously named by the writer, it is difficult to understand. Perhaps the authors of this book may have some plausible explanation.

#### B. TWO GENERA WITH THE SAME TYPE

The authors (page 328) have treated *Detonia* of Saccardo as typified by *Peziza leiocarpa* Curr. as a synonym of *Lamprospora* following the work of the writer (*North American Cup-fungi*, 54. 1928) in this procedure. On the same page, however, they treat *Plicariella* Saccardo typified by the same species *Peziza leiocarpa* Curr. as a valid genus. Of course this is impossible. So far as the writer is aware Saccardo never used the name *Plicariella* except for a subgenus of *Phaeopezia* (*Bot. Centr.* 18: 218). Lindau (*E. & P. Nat. Pfl.* 1<sup>1</sup>: 179) made Saccardo's *Plicariella* a genus but treated *Detonia* as a synonym as has been done in *North American Cup-fungi* (54). Just why Clements and Shear should have separated the two but leave them typified by the same species it is difficult to explain. Apparently just another bungle.

#### C. INVALID NAMES

The genus *Durandia* was described by Rehm (*Ann. Myc.* 11: 166. 1913. Not *Durandia* Bockel. 1896) and based on specimen sent by Dr. E. J. Durand. A most casual survey of the literature would have revealed to the authors of this work the fact that the name was and is untenable, or this information might have been had for the asking since the writer had already proposed for his forthcoming monograph the name **Durandiella** nom. nov. to replace the untenable *Durandia* of Rehm and still keep the genus in honor of our late E. J. Durand.

The generic name *Haematomyces* is also untenable in the sense used by the authors as has been pointed out by Petch (*Ann. Bot.* 33: 405. 1919) and by the writer (*MYCOLOGIA* 22: 52. 1930). In March, 1930 the writer proposed and published the genus *Ascotremella* to replace the untenable *Haematomyces*. Since this name, *Ascotremella*, does not appear in their synonymy, we assume that it was an oversight or perhaps it was too recent. However, the fact that Honey's genus *Monilinia*, published in the same work (*MYCOLOGIA* 20: 153. 1928) does not appear in their index leads the writer to suspect that possibly the authors do not have access to this publication.

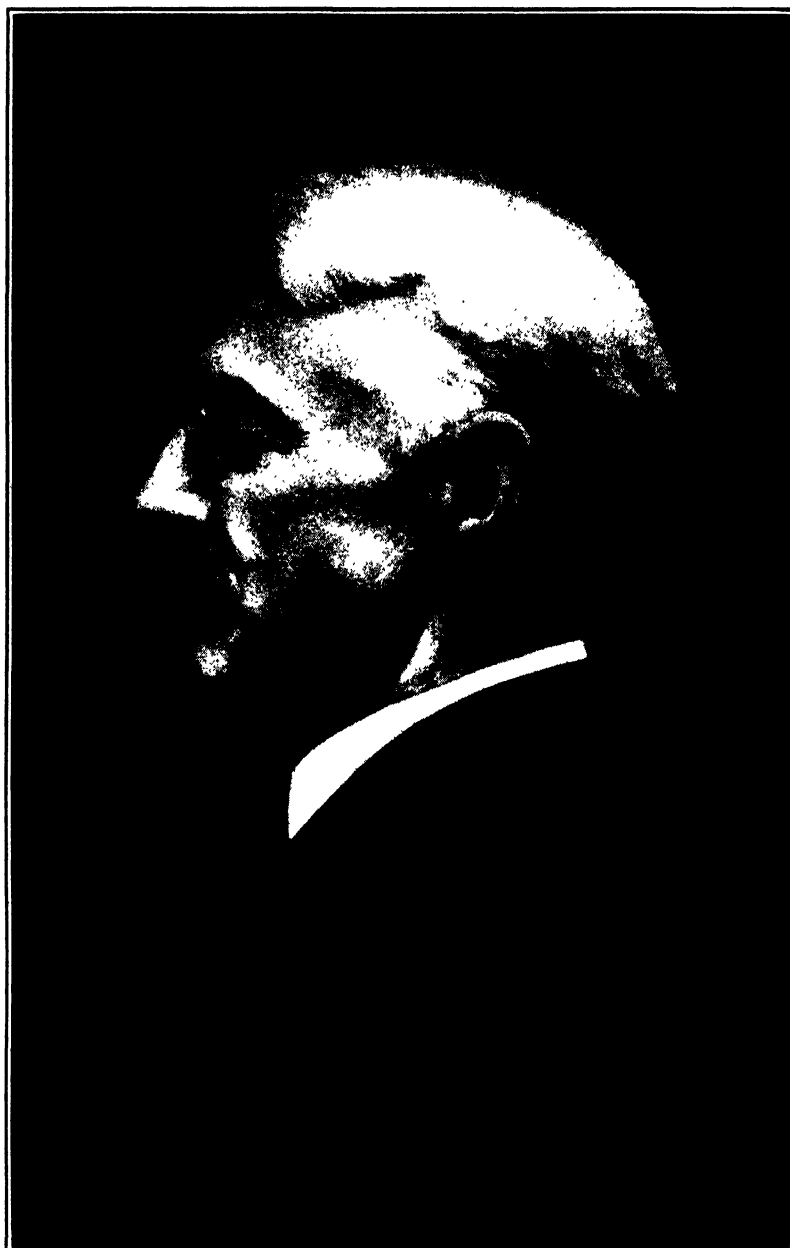
The persistent use of invalid names by the authors of this work is apparently one of the privileges which is claimed on the ground of "usage" which seems to be merely another name for "anarchy" or total disregard for all nomenclatorial rules. Just how stability of nomenclature can ever be brought about by such a procedure, if indeed it can ever be brought about at all, it is difficult for the writer to comprehend. If mycologists cannot agree on a uniform system of rules how can they ever agree on usage? While the rigid enforcement of rules may bring about some temporary confusion the total disregard of such rules can result in nothing but permanent chaos, of which the present volume is a striking illustration.

## CONCLUSION

Unfortunately the writer has not had time to make a critical study of all the genera of even his own groups as represented in this new work. The above are but a few of the many outstanding errors and irregularities detected in a very casual survey. If the treatment of the genera of the cup-fungi may be taken as a fair sample, this work could truthfully be characterized as the largest volume of misinformation, inconsistencies, and contradictions which the writer has ever encountered. Yet the authors state "*It is hoped that most of the types selected here will be found acceptable and generally adopted*," supposedly by the International Commission on Nomenclature. This would be equivalent to the establishment of a "dictatorship" in the field of taxonomic my-

cology. To even cherish such hope in the light of the above facts is absurd. It is regrettable that such a pretentious volume should have been sponsored by one who is not primarily a mycologist and who has so little critical knowledge of the fungi in general and apparently less knowledge of the mycological literature which has appeared in the last twenty years. As stated above these comments apply only to the groups in which the writer has done critical work. Each mycologist must judge for himself as to the merits of the work in his own particular field.  
—F. J. SEAVER.





CALVIN HENRY KAUFFMAN

# MYCOLOGIA

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## CALVIN HENRY KAUFFMAN

E. B. MAINS

(WITH PLATE 6)

Calvin Henry Kauffman was born March 1, 1869, on a farm near Lebanon, Pennsylvania. Here his close contact with nature early developed an interest in botany. While still in preparatory school he studied the flora about Lebanon and started his herbarium of flowering plants. However, during his undergraduate years at Harvard, he specialized in languages and devoted but little attention to science, taking three courses in chemistry and one in botany. He received the A.B. degree from Harvard in 1895.

Following his graduation, he taught for several years in the public schools of Pennsylvania, Indiana and Illinois. In 1900, while teaching in a normal school at Bushnell, Illinois, his scientific inclinations were stimulated, apparently as a result of giving a course in chemistry. Also at this time he obtained a copy of Atkinson's "Mushrooms" and spent many happy hours studying the agarics of the vicinity. As a result, he decided to specialize in science and spent the following year (1901-1902) at the University of Wisconsin where he took courses in botany and chemistry. Here he came under the influence of Professor R. A. Harper, and through him became interested in and started his studies of the Saprolegniaceae.

The following two years (1902-1904) were spent at Cornell University where he was a personal assistant to Professor G. F. Atkinson. He seized the opportunity thus offered to study agarics and spent a considerable portion of his time on that

[MYCOLOGIA for March-April (24: 187-263) was issued March 1, 1932]

group. Encouraged by Professor Atkinson, he devoted special attention to the genus *Cortinarius*.

In 1904 he accepted an instructorship in the department of botany of the University of Michigan. Here he continued his studies, both in the Saprolegniaceae and Agaricaceae. In 1907, he received the degree of Ph.D. from the University of Michigan. He presented a dissertation entitled "A Contribution to the Physiology of the Saprolegniaceae, with Special Reference to the Variations of the Sexual Organs."<sup>1</sup> In this study he was successful in showing that reproduction in the Saprolegniaceae could be controlled with remarkable accuracy by the use of proper nutrient media. In this his results were in agreement with the results and theories of Klebs. These principles influenced to a marked degree all his future physiological studies.

During his early years at Michigan he threw himself enthusiastically into the study and development of cryptogamic botany. For a number of years he taught courses in algae, mosses and ferns, general and advanced mycology and pathology, and forest pathology. During his later years he limited his teaching largely to mycology and forest pathology. He was an enthusiastic and inspiring teacher, and had the ability to transmit his enthusiasm to his students to a remarkable degree.

He was much interested in the growth of the herbarium at Michigan. He not only added his own extensive collections, but also devoted much time to planning and supervising its development. In 1921 he was made director. It grew rapidly and in 1928 moved into more commodious quarters in the Museums Building, becoming one of the University Museums. In 1928 he was able to announce the acquisition of the extensive Krieger Mycological Library and Collections, a gift of Dr. Howard A. Kelly. The following year he still further added to the facilities by the purchase of the lichen herbarium and library of Professor Bruce Fink. Unfortunately, he did not long enjoy the facilities that he had worked so hard to create.

Doctor Kauffman published 42 papers,<sup>2</sup> mostly on mycological subjects. His most extensive and outstanding publication is

<sup>1</sup> Ann. Bot. 22; 361-387. 1908.

<sup>2</sup> A complete bibliography is given in Phytopathology.

"The Agaricaceae of Michigan"<sup>3</sup> in which he described 884 species of agarics illustrated with 172 plates. It is remarkable for its clear descriptions and critical delimitation of species. He also has monographed the genera *Armillaria*,<sup>4</sup> *Inocybe*,<sup>5</sup> *Lepiota*,<sup>6</sup> *Gomphidius*,<sup>7</sup> *Flammula* and *Paxillus*,<sup>8</sup> and *Clitocybe*.<sup>9</sup> He described more than 200 new species of fungi, from not only the Agaricaceae but also many other groups.

He was much interested in the flora of Michigan and was one of the principal contributors to our knowledge concerning it. He was also specially interested in the flora of the Rocky Mountains and the Pacific Northwest and spent many summers with his students in Washington, Colorado, Idaho, Wyoming and Oregon. He also spent one summer in Tennessee and Kentucky, and another in North Carolina and Tennessee. The results of these studies have been published in the Papers of the Michigan Academy of Science, Arts and Letters. He had planned critical studies of a number of other genera of the Agaricaceae, and left manuscripts in various stages toward completion. His death is a distinct loss to mycology. He has enriched our knowledge of the fungi of North America, and by his critical studies has established bases for future investigations.

Doctor Kauffman was advanced from the rank of instructor to that of assistant professor in the University of Michigan in 1912, associate professor in 1920 and professor in 1923. He was made professor emeritus and director emeritus in January 1931 following his illness. He died at the age of 62 at his home in Ann Arbor, Michigan, June 14, 1931. He is survived by his wife Elizabeth Catherine Kauffman.

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<sup>3</sup> Mich. Biol. and Geol. Surv. Publication 26, Biol. Surv. 5, Lansing, Michigan. 1918. Vol. I, 924 pages. Vol. II, 172 plates.

<sup>4</sup> The Genus *Armillaria* in the United States and its Relationships. Papers Mich. Acad. Sci. Arts and Letters 2: 53-66. 1922.

<sup>5</sup> *Inocybe*. N. Am. Fl. 10: 227-260. 1924.

<sup>6</sup> The Genus *Lepiota* in the United States. Papers Mich. Acad. Sci. Arts and Letters 4: 311-344. 1924.

<sup>7</sup> The Genus *Gomphidius* in the United States. Mycologia 17: 113-126. 1925.

<sup>8</sup> The Genera *Flammula* and *Paxillus* and the Status of the American Species. Am. Jour. Bot. 13: 11-32. 1926.

<sup>9</sup> The Genus *Clitocybe* in the United States with a Critical Study of All the North Temperate Species. Papers Mich. Acad. Sci. Arts and Letters 8: 153-214. 1927.

# OBSERVATIONS ON THE AQUATIC FUNGI OF COLD SPRING HARBOR <sup>1</sup>

F. K. SPARROW, JR.

(WITH PLATES 7 AND 8 AND 4 TEXT FIGURES)

## INTRODUCTION

Inasmuch as the region around Cold Spring Harbor, L. I., has long been, and will continue to be, the site of various types of biological investigation, it seems fitting to add to the fund of knowledge already accumulated certain observations on a group of little known aquatic fungi which apparently abound in the fresh water lakes of that vicinity. The observations herein described, which have been pursued over a period of four summers in the interim of teaching duties, have proved to be of more than local interest, for many of the species found apparently have never, heretofore, been reported as occurring in North America.

Few investigations of a similar nature have been undertaken in this country (Coker, Couch, et al.; Graff). With the exception of Couch's paper reporting various saprolegniaceous forms found at Cold Spring Harbor (9), the localities previously investigated by other workers have been relatively remote from the present one. Several other papers on aquatic fungi are monographs of particular groups (Humphrey (13), Kanouse (14)). These, and the occasional papers of Thaxter, Karling, and a few others, represent nearly our entire knowledge of the aquatic fungi of this country. In Europe, a number of such papers have been published (A. Braun, Zopf, Fischer, Minden, Sorokin, Dangeard, deWildeman, Apinis, Petersen, Scherffel, Valakanov, Tiesenhäusen, etc.) although even there the amount of investigation accorded these fungi has not been adequate.

One very well known group of aquatic Phycomycetes has been given scant attention in this paper, namely, the Saprolegniaceae.

<sup>1</sup> The preparation of this paper has been greatly facilitated by the kindness of the Board of Trustees of Dartmouth College in granting the writer leave of absence in order to accept a National Research Fellowship.

This has not been due to the lack of these organisms in the region, but rather to the writer's greater interest in the lesser known algal and twig-inhabiting forms. A few of the more interesting of the Saprolegniaceae have, however, been included. Couch (9, 10) has recently secured a number of interesting members of this group from the vicinity of Cold Spring Harbor.

It should be emphasized at this point that this paper is primarily a taxonomic one and not an attempt to give the complete, detailed morphology and development of each of the fungi herein mentioned. Certain phases, however, which are essential to the proper identification of a particular organism, are in some cases dealt with in detail.

#### MATERIALS AND METHODS

The fungi described in this paper were all found in the immediate vicinity of the Biological Laboratory of the Long Island Biological Association at Cold Spring Harbor, N. Y. Other stations in the United States where these fungi have been collected by the writer, or by other investigators, are also included in the data.

Several methods of procedure were followed in obtaining material. Algae, submerged twigs, apples, etc., were brought in from their aquatic habitats and immediately examined for fungi which might be present. A second method involved bringing in this material and, after an immediate examination for fungi, placing it in sterile, distilled water and examining it at intervals. Often, fungi which were present on the substratum at the time of collection, but were not visible, would, under these conditions, produce an abundant growth. Various types of bait were left in pools and collected sometime later and the fungi thus obtained, studied. Another method was to collect sphagnum, or trash of various sorts from aquatic habitats, seal it up in waxed cardboard containers, and send it to the laboratory where one was working. The material was then placed in jars in a suitable amount of sterile distilled water. The water cultures thus obtained were then baited with various types of animal and vegetable substrata. In addition, the algae which invariably develop in such cultures when there is a sufficient amount of

light would often be attacked by chytridiaceous organisms. By this method, representatives of the flora of a locality could be studied, even though one was at some distance from the site.

In identifying the fungi found by the aforementioned methods, the monograph of the aquatic Phycomycetes by Minden (20) was used. Determinations were supplemented in all cases by comparisons with the original descriptions. Later treatments of special groups were also consulted.

## OBSERVATIONS AND RESULTS

### CHYTRIDIALES

#### FAM. WORONINACEAE

OLPIDIOPSIS SAPROLEGNIAE Cornu (sensu lat. Barrett), Ann. Sci. Nat. V. 15: 145. 1872. Barrett, Ann. Bot. 26: 232. 1912. *Olpidiopsis echinata* Petersen, Ann. Myc. 8: 540. 1910.

A form, at first considered *O. echinata*, was found parasitic in *Achlya*, in 1927. After a perusal of Cornu (l.c.), Barrett (l.c.), and Petersen's (l.c.) papers, the writer does not feel that there are sufficient grounds for the latter investigator's fungus remaining as a distinct species and it is therefore merged with *O. Saprolegniae*.

The sporangia are elliptical to sub-spherical,  $45-50 \times 30-36 \mu$ , with a single tube of discharge, usually about  $48 \mu$  long and about  $5.4 \mu$  in diameter. The zoöspores are biciliate and about  $2.5-3 \mu$  in length. The resting spore is usually about  $47.3 \mu$  in diameter and is beset with slender spines  $5.3 \mu$  in length (TEXT FIG. 1, c); the companion cell, of which only one was attached to an "oögonium" in this material, is smooth, and about  $25.5 \mu$  in diameter. The resting spore with a tuberculate outer wall, ordinarily described as that of this species, is, as Barrett has shown, different from Cornu's fungus and has been termed *O. vexans* Barrett (12).

In filaments of *Achlya* sp.(?), Jarvis Pool, June, 1927. New York (Barrett). Coker's fungus (7) seems to be *O. luxurians* Barrett.

OLPIDIOPSIS MINOR A. Fischer, in Rab. Krypt.-Fl. 14: 39. 1892. *Olpidiopsis fusiformis* Cornu, pro parte (l.c.), p. 147, pl. 4, figs. 3a and 4. Reinsch, Jahrb. Wiss. Bot. 11: 304. 1878, pl. 17, fig. 1.

The distinguishing feature of this species is its coarse, abruptly tapering spines as compared with the slender ones of the preceding species and of *O. luxurians* Barrett. These resting spores are  $34.5\text{--}52.6\ \mu$  in diameter and the spines are about  $10.5\ \mu$  in length (TEXT FIG. 1, F, G). The companion cell, which is smooth, is about  $18.5\ \mu$  in diameter. The sporangia of this

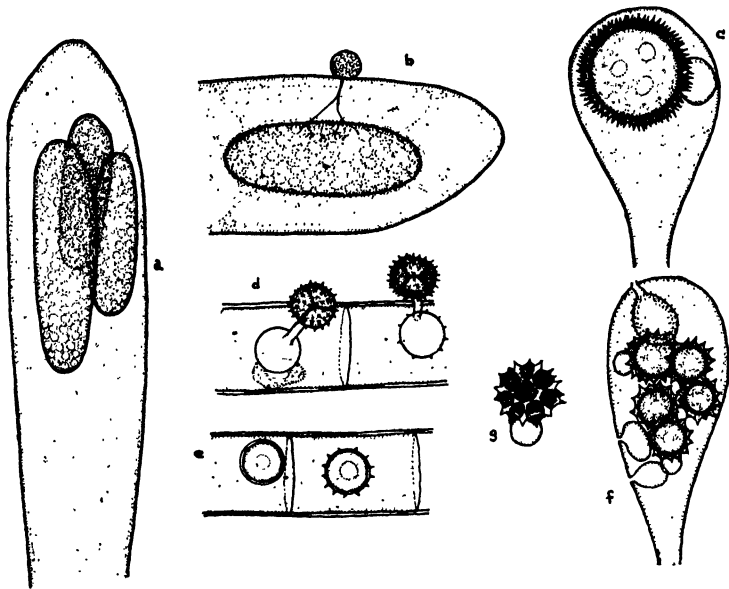


FIG. 1. (a) *Pseudolpidium fusiforme*. Immature sporangia in filament of *Achlya* ( $\times 365$ ). (b) *Rhizophidium carpophilum*. Nearly mature sporangium; parasitic in *Olpidiopsis*, which in turn is parasitizing *Achlya* ( $\times 365$ ). (c) *Olpidiopsis Saprolegniae*. Resting spore and companion cell in *Achlya* ( $\times 260$ ). (d) *Micromycopsis cristata* var. *minor* n. var. Extramatrix, spiny sori produced by germinating, intramatrix resting spores ( $\times 670$ ). (e) Resting spores of same fungus ( $\times 670$ ). (f) *Olpidiopsis minor*. Habit of resting spores and sporangia in *Achlya* ( $\times 260$ ). (g) Resting spore and companion cell of same fungus in surface view.

fungus were found in the same cells as those which contained resting spores. These sporangia were  $21.7\ \mu$  long by  $10.4\ \mu$  in diameter (although these dimensions varied somewhat), and were sometimes beset with very tenuous spines. The discharge tube, through which the biciliate zoöspores were discharged, was about  $2.6\ \mu$  in diameter and varied slightly in length (TEXT FIG.



1, F). Fischer (l.c.) states that the sporangia of this species are small, while Butler (4) describes them as being large, spherical, and 80–120  $\mu$  in diameter. Neither mentions spines as being present. While it is possible that we may be dealing with a distinct species in the present instance, in view of the variation in echinulation found among sporangia of the American material and the variations in size of the sporangia of other species reported by Barrett, specific distinction does not seem warranted at this time.

The fungus figured by Petersen (l.c. FIG. 18, G) possesses too many and too slender spines to be this species and probably should be referred to *O. luxurians* Barrett (cf. Barrett's PL. 23, FIG. 21, B). The form found in India by Butler (l.c.) agrees with the present material with respect to the resting spore, but, as has been stated, possesses somewhat larger sporangia. Reinsch (l.c.) figured sporangia similar to those of the Cold Spring Harbor material, with respect to shape. Minden (20) and Fischer have indicated that they regard the sporangia figured by Reinsch as those of *Pseudolpidium fusiforme* (Cornu) Fischer, but the writer can find no evidence, other than a slight similarity in shape, to support this view. From observations on the development, discharge, and size of these sporangia, similar to those found by Reinsch, the writer is convinced that these are the sporangia of *O. minor*.

Parasitic in filaments of *Achlya* and *Saprolegnia* spp.(?), various pools and springs in the vicinity of the Laboratory, August, 1930.

PSEUDOLPIDIUM FUSIFORME (Cornu) Fischer, l.c. p. 35.

*Olpidiopsis fusiformis* Cornu, l.c. p. 147, pro parte, pl. 4, figs. 1–3s. (Not the resting spores.)

The vegetative stage of this fungus is quite characteristic and the large elliptical bodies (TEXT FIG. 1, A) which will become sporangia are found quite commonly in various saprolegniaceous forms. The sporangia vary somewhat in size, being in the present material about 105–131  $\mu$  long, by 26–31  $\mu$  in diameter. The resting spores, which were not observed, are said by Fischer (l.c.) to resemble the sporangia in shape, and to be beset with numerous spines.

Parasitic in *Achlya* and *Saprolegnia*, Jarvis Pool, 1927.

WORONINA POLYCYSTIS Cornu, l.c. p. 176.

Both the clusters of spherical sporangia contained in walled-off portions of the host and the erumpent "cystosori" were observed in filaments of *Achlya*. The parasite produced a marked hypertrophy of the host cell which involved a pronounced swelling of the infected parts. Unfortunately, the figures and measurements of this and the succeeding fungus, with which it occurred, have been lost, but from other notes taken at the time and from personal recollection, the identities of these two fungi are expressed with certainty.

Parasitic on *Achlya* sp.(?), Jarvis Pool, 1927.

ROZELLA SEPTIGENA Cornu, l.c. p. 163.

This fungus was found, along with the preceding one, infecting filaments of *Achlya*, in which it produced a linear series of sporangia blocked off from each other by cross walls laid down by the host. In contrast to the preceding species, the sporangia of this fungus occupied the whole of the blocked-off portion of the host cell. No resting spores were observed.

Parasitic in *Achlya* sp.(?), Jarvis Pool, 1927.

#### FAM. SYNCHYTRIACEAE

**Micromycopsis cristata** var. **minor** Sparrow, var. nov.

The genus *Micromycopsis*, based on *M. cristata*, has recently been erected by Scherffel (24) to include those *Micromyces*-like forms which, upon germination of the pro-sorus, produce a short tube through which the content of the fungus passes to the outside of the host cell. There it becomes invested with a membrane, which in the present species is covered with spines. From this body, upon germination, there is produced, according to Scherffel, amoeboid spores, which, he thinks, probably give rise in turn to motile spores. Just what happens in the germination of the sorus and sporangium is not clear from Scherffel's account, and, as the present writer observed no germination of the sori, he can add nothing at this time concerning this point.

The pro-sorus within the host cell was spherical and possessed a thick brown wall which was beset, in most instances, with a

helicoid series of spines (TEXT FIG. 1, E). These bodies were  $8.5\text{--}10.4\ \mu$  (usually about  $8\ \mu$ ) in diameter, which was smaller than that given by Scherffel ( $11\text{--}20\ \mu$ , mostly  $14\ \mu$ ). The extramatrical, spiny-walled sorus upon germination undoubtedly splits along the sutures which are visible in the mature resting sorus (TEXT FIG. 1, D). In some sori it is possible to observe that the content, before germination, has separated into three tetrahedral portions. Further phases in the germination did not take place, and the fate of the sporangia, while they will probably behave as those of *Micromyces*, must await further investigation. The sorus was consistently about one-half the size of *M. cristata* ( $7.8\ \mu$  in diameter vs.  $14\ \mu$ ). Such a constant discrepancy in size, in view of the lack of evidence from cross inoculation experiments on different hosts and resulting data on variations in size, etc., seems of little significance in segregating the present fungus as a new species. It does, however, seem worthy of recognition as a variety, and the name *minor* is therefore proposed for it.

It is quite possible that in the future when more organisms similar to *Micromycopsis* and *Micromyces* have been investigated in detail, the former genus may be found to be superfluous.

#### FAM. RHIZIDIACEAE

PHILYCTIDIUM LATERALE A. Braun, Abh. Akad. Berlin 1855: 41.  
*Chytridium laterale* Br. (l.c.).

*Rhizophidium laterale* (Br.) Raben. Flor. Eur. Alg. 3: 281.

The spherical extramatrical sporangia of this fungus (TEXT FIG. 2, G) were  $10\text{--}14\ \mu$  in diameter and possessed a single, somewhat irregular, inflated "rhizo-haustorium,"  $2\text{--}4\ \mu$  in diameter, which penetrated deep into the zygote of the alga. The zoöspores were formed within the sporangium and were discharged upon the deliquescence of a sub-apical papilla, one by one, in typical *Rhizophidium*-like fashion. They are of the uniciliate, chytrid type.

The haustorium of this species, as figured by Braun (l.c. PL. 3), is shorter and straighter than the present form, but this seems a minor difference. The papillae of Braun's fungus were usually more laterally placed than those found on the American material,

but variations in this respect are found even in the original figures of this species (cf. Braun's PL. 3, FIGS. 23, 25). The form termed *Rhizophidium carpophilum* by Coker (7) probably is this species.

Parasitic in zygote of *Spirogyra* sp.(?), Fish Hatchery, 1927.

*RHIZOPHIDIUM POLLINIS* (A. Braun) Zopf, Abh. Nat. Ges. Halle 17: 82. 1888.

*Chytridium pollinis Pini* A. Br., Monatsber. Akad. Berlin 1855: 381. Abh. 1855: 40.

*Chytridium vagans* A. Br., Monatsber. Akad. Berlin 1856: 588.

This is perhaps the most common and most easily obtained of all the chytrids. It occurs commonly on pine pollen which has

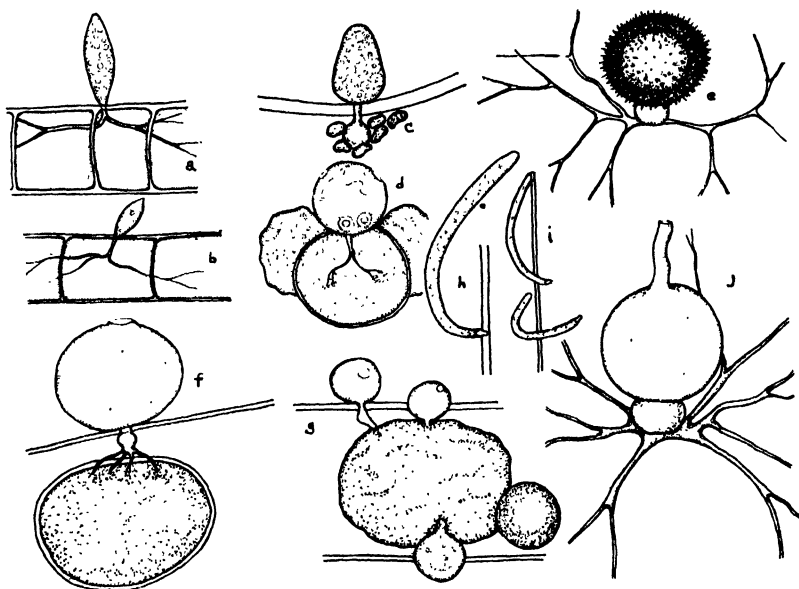


FIG. 2. (a) *Rhizophidium Fusus*. Habit of plant in *Melosira* ( $\times 670$ ). (b) Smaller sporangium of same fungus in a smaller species of *Melosira* ( $\times 670$ ). (c) *Phlyctochytrium Hydrodictyii*. Mature sporangium, parasitic in *Rhizoclonium* ( $\times 750$ ). (d) *Rhizophidium pollinis*. Discharged sporangium, parasitic in a pollen grain ( $\times 375$ ). (e) *Diplophlyctis intestina*. Resting spore in *Nitella* ( $\times 670$ ). (f) *Rhizophidium vernale*. Discharged sporangium, parasitic in zygote of *Spirogyra* ( $\times 580$ ). (g) *Phlyctidium laterale*. Sporangia, parasitic in zygote of *Spirogyra* ( $\times 580$ ). (h) *Harpochytrium Hedenii*. Sporangium on *Oedogonium* ( $\times 670$ ). (i) Same fungus, on *Spirogyra* ( $\times 670$ ). (j) *Diplophlyctis intestina*. Discharged sporangium, in *Nitella* ( $\times 670$ ).

fallen in the water, but has also been reported on pollen of other types. The sporangia are spherical, extramatrical, 18–26  $\mu$  in diameter, and possess a sparingly branched, intramatrical, rhizoidal system (TEXT FIG. 2, D). The zoöspores which are uniciliate with a prominent oil globule, are about 3.5  $\mu$  in diameter and escape from the sporangium through several sub-apical pores. Thick-walled extramatrical resting spores, the same size as the sporangia, with a large oil globule, are often found.

Saprophytic in pine pollen, Second Lake, 1928; Fish Hatchery, 1929; Cambridge, Mass., 1929; Hanover, N. H., 1930; Wisconsin (Melhus); Montana (Graff).

*RHIZOPHIDIUM FUSUS* (Zopf) Fischer, l.c. p. 99.

*Rhizidium Fusus* Zopf, Nova Acta Akad. Leop.-Carol. 47: 199–1884.

Sporangium narrowly to broadly fusiform, nearly always slightly tilted; 10.4–20  $\mu$  long by 3–8  $\mu$  in width; extramatrical; rhizoidal system stout, especially at the base of the sporangium, extensive, ramifying in many cases through 5–6 cells of the host and causing a pronounced disintegration of the content of the latter (TEXT FIG. 2, A, B). The zoöspores are very minute, 2–2.5  $\mu$  in diameter, each with a single cilium and an oil globule. They escape from the sporangium through an apical pore.

As has been suggested by Fischer and Minden (20), this species is doubtfully distinct from *R. lagenula* (A. Br.) Fischer. Indeed, save for the more fusiform shape and tilting of the sporangium, the writer can find no distinction between them. However, these two characters seem sufficiently distinctive and constant to maintain Zopf's species.

Parasitic in *Melosira* spp., Fish Hatchery, 1930.

(?) *RHIZOPHIDIUM CARPOPHILUM* (Zopf) Fischer, l.c. p. 95.

*Rhizidium carpophilum* Zopf, l.c. p. 200.

A form which seems morphologically to agree with Zopf's fungus was found parasitic in *Olpidiopsis Saprolegniae*, which in turn, was parasitizing a species of *Achlya*. The spherical, extramatrical sporangium was about 12–20  $\mu$  in diameter and possessed a slender intramatrical rhizoid, which was rarely branched (TEXT FIG. 1, B). As no zoöspore emergence was observed, the

positive identification of this species could not be made; however, from its dimensions, rhizoidal system, and habitat, this form closely resembles Zopf's species. Coker's fungus of this name appears to be a *Phlyctidium* (7).

Parasitic in *Olpidiopsis Saprolegniae* (sporangium), Jarvis Pool. 1927.

**Rhizophidium vernale** (Zopf) Sparrow, comb. nov.

*Rhizidium vernale*, Zopf, l.c. p. 234, description of pl. 10, figs. 12–20; (no description in text).

*Phlyctochytrium vernale* (Zopf) Schröter, E. & P. Nat. Pfl. 1<sup>1</sup>: 78. 1892.

Sporangium extramatrical, spherical to sub-spherical, 20–25  $\mu$  in diameter; opening by an apical papilla, allowing the fully formed zoöspores to escape. The latter are spherical, uniciliate, and possess a refractive oil globule. The rhizoids of this fungus are stout, and near the point of attachment to the sporangium, before branching has occurred, the main "trunk" may be slightly inflated (TEXT FIG. 2, F).

This fungus was placed by Schröter (l.c.) in *Phlyctochytrium*, along with the other species of Fischer's genus *Rhizidium*, and was retained there by Minden, because of the slight inflation of the unbranched portion of the rhizoid. The latter structure is, indeed, as Minden (20) says, ". . . nur noch als schwache Anschwellung. . . ." To the writer's mind, it would seem better to place this form in *Rhizophidium*, as the inflation of the rhizoid, while sufficient to distinguish this form from other uniporous species, is not so convincing a generic character in this instance.

Parasitic in the zygote of *Spirogyra* sp.(?), Fish Hatchery, 1927.

PHLYCTOCHYTRIUM HYDRODICTYII (A. Braun) Schröter, l.c. p. 78.

*Chytridium Hydrodictyii* A. Braun, Monatsber. Berlin Akad. 1855: 383.

*Rhizidium Hydrodictyii* (Br.) Fischer, l.c. p. 108.

The pyriform sporangia of this fungus were extramatrical, 15  $\mu$  long by 5–10  $\mu$  in diameter (TEXT FIG. 2, c). Within the host cell a definite, spherical, subsporangial swelling, about 5  $\mu$  in diameter, was always present. No rhizoids could be detected

in the dense content of the infected alga, nor were any observed on the somewhat larger sporangia figured by Braun. The zoöspores of our species were about  $3\ \mu$  in diameter and escaped, fully formed, by means of the deliquescence of an apical pore, as in *Rhizophidium*. These spores were similar to those of the latter genus.

To the writer's mind, this fungus is a true *Phlyctochytrium*, applying this generic term in its strictest sense.

Parasitic in *Rhizoclonium hieroglyphicum*, Fish Hatchery, 1927; Cambridge, Mass., 1928.

PHLYCTOCHYTRIUM PLANICORNE Atkinson, Bot. Gaz. 48: 337. 1909.

The sporangia of this species, when mature were about  $8\ \mu$  long by  $6\ \mu$  in diameter, and each possessed at its apex, four plain teeth. These dentations were not bipartate, as have been figured by deBary and Rosen (23) for *P. Zygnematis*, *P. dentitum*, and *P. quadricorne*. At the base of the sporangium, within the host cell, there was a definite swelling, which varied from a pronounced fusiform enlargement to a well formed, spherical structure. Gradations from one to the other of these shapes were often observed on sporangia occupying a single algal filament (TEXT FIGS. 3, E, F, G, K). The rhizoidal system which emanated from the sub-sporangial swelling was extremely variable in the amount and extent of its branching (TEXT FIGS. 3, G, J).

The zoöspores, which are partially formed within the sporangium, are finally fashioned outside the latter structure in a vesicular membrane (TEXT FIG. 3, E). They are ultimately liberated into the outside medium by the bursting of the membrane. These spores are about  $3\ \mu$  in diameter, uniloculate, and possess a single, refractive oil globule (TEXT FIG. 3, I). After a period of motility the zoöspore comes to rest on an algal filament, absorbs its cilium, and produces a needle-like tube which penetrates the wall of the host. Within, there is at once formed a small, irregular swelling from which rhizoids arise (TEXT FIG. 3, H). The body of the zoöspore increases in size and soon forms the characteristic apical teeth. Subsequent growth involves an enlargement of the intra- and extramatrical parts, and often the extension of the rhizoidal system of the fungus.

From the accounts of Rosen (23) and Scherffel (24), it is probable that in this *Dentigera* group, there is some variation with respect to the stage in their maturation at which the zoöspores are liberated from the sporangium proper. Both of these investigators, the former observing *P. Zygnematis* (Rosen) Schröter, the latter "*Rhizidium quadricorne* deBary" (from his figures, probably *P. planicorne*), indicate that the zoöspores are fully

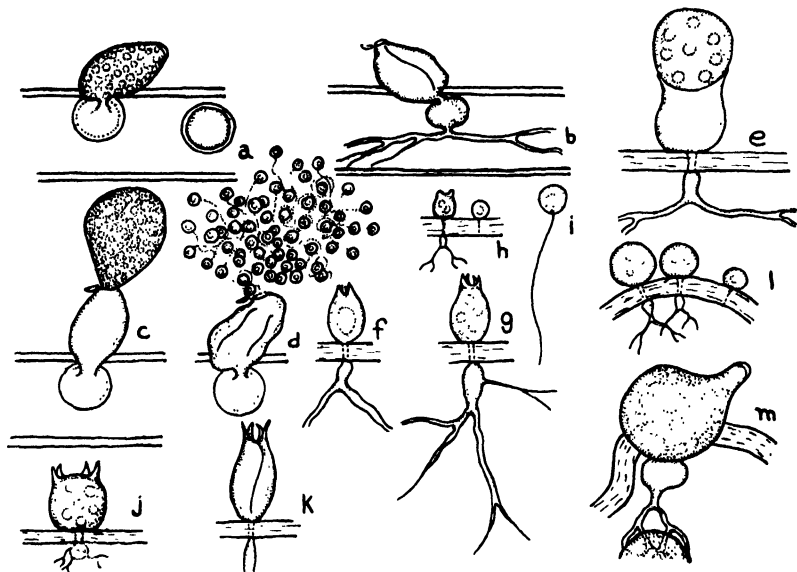


FIG. 3. (a) *Chytridium Schenkii*. Germinated and ungerminated resting spore in *Oedogonium* ( $\times 600$ ). (b) Discharged sporangium of the same fungus ( $\times 600$ ). (c) *C. Schenkii*. Discharge of zoöspores from sporangium formed by germinating resting spore ( $\times 600$ ). (d) Dispersal of zoöspores, same fungus ( $\times 600$ ). (e) *Phlyctochytrium planicorne*. Discharging sporangium in *Rhizoclonium* ( $\times 600$ ). (f, g) Sporangia of same fungus showing variation in subsporangial swelling ( $\times 670$ ). (h) Zoöspore penetration and early stage in sporangial development of same fungus. (i) Zoöspore of *P. planicorne* ( $\times 670$ ). (j) Sporangium of same fungus with spherical apophysis ( $\times 750$ ). (k) Discharged sporangium of same species with fusiform apophysis ( $\times 670$ ). (l) *Rhizidiomyces apophysatus*. Penetration of the zoöspore and early stages in the development of the sporangia ( $\times 670$ ). (m) Nearly mature sporangium of the same fungus in *Achlya* ( $\times 670$ ).

formed before emergence from the sporangium. In the present material, as has been intimated, while cleavage of the zoöspores had been initiated before discharge, these bodies seemed to be finally fashioned in the extruded membrane. All accounts agree,



however, that the zoöspores do not escape singly, as in *Rhizopodium pollinis*, etc., but pass out of the sporangium in a mass, surrounded by a membrane which has been extruded from the sporangium. Only after the deliquescence or rupture of this sac are the zoöspores finally liberated into the water.

No resting spores have been observed in any member of this group.

Parasitic in *Spirogyra* sp. (?) and *Rhizoclonium hieroglyphicum*, Fish Hatchery Pond near Schoolhouse; 1928; Cambridge, Mass., 1927; Ithaca, N. Y. (Atkinson).

The genus *Phlyctochytrium*, as it is now understood, seems wholly unsatisfactory. It includes forms with a *Rhizopodium*-like type of non-sexual reproduction (*P. Hydrodictyii*, etc.), and forms in which zoöspore production approximates that of *Rhizidium*. To the writer's mind, the *Dentigera* of Rosen should be removed from the Rhizophidieae, where they are now listed by Minden (20), and placed in the Rhizidieae, near *Saccomyces* and *Rhizidium*.

CHYTRIDIUM SCHENKII (Dangeard) Scherffel, Arch. Protistenk. 54: 237. 1926.

*Rhizidium Schenkii*, Dangeard, Ann. Sci. Nat. VII. 4: 297. 1886.

*Rhizidium intestinum* Schenk, pro parte, Über das Vorkommen kontraktiler Zellen im Pflanzenreiche. Würzburg. 1858.

*Phlyctochytrium Schenkii* (Dang.) Schröter, l.c. p. 78.

The writer's attention was first directed to this fungus by observing the germination of its intramatrical resting spores. These bodies, which were probably first seen in this species by Petersen (22), are smooth, thick-walled, about 10  $\mu$  in diameter, and possess a highly refractive, oily content (TEXT FIG. 3, A). No rhizoids were seen in connection with these bodies. Germination, which has apparently hitherto been unobserved, was accomplished by the extrusion from the resting spore to the outside of the host cell of an elongate, sac-like body, about 15  $\mu$  long by 10  $\mu$  in diameter (TEXT FIG. 3, A). This structure, which may be regarded as a sporangium, is filled with finely granular protoplasm in which there are interspersed minute oil droplets. At the apex of the sporangium, there is formed a hyaline oper-

culum, about  $3\ \mu$  in diameter. Coincident with the production of this cap, the oil droplets within the sporangial protoplasm become organized into many refractive globules of the same size and placed approximately the same distance apart. Cleavage furrows are not apparent now within the sporangium. After a short time, the operculum is thrown back and the protoplasm emerges, only partially cleaved into spores. The discharged protoplasm is surrounded by a flask-shaped membrane of an exceedingly tenuous nature (TEXT FIG. 3, C). Within this, the zoöspores are finally fashioned, although in contrast to such forms as *Lagenidium* and *Pythium*, there is no active movement on the part of the swarmers during this process. After 5–10 minutes the vesicular structure breaks, apparently because of the steady increase in the size of the spores as they mature. The latter are forcibly ejected from their former positions and remain motionless for a brief interval, distributed in a fan-shaped manner (TEXT FIG. 3, D). They then uncoil their cilia, which were not previously observed, and dart away. The zoöspore is spherical, about  $2\ \mu$  in diameter, with a minute oil droplet and a cilium about  $10\ \mu$  in length.

In the foregoing account of zoöspore formation, it cannot be said with certainty whether the discharged zoöspores were held in place by a definite membrane or whether they were merely imbedded in a viscid substance. However, the impression one obtained from observing the discharge, maturation, and subsequent dispersal of the spores tended to support the theory that a definite surrounding membrane was present.

Sporangia were also observed, though less frequently than germinating resting spores. The former were of the same size and shape as those produced by the germinating resting spores. Each sporangium possessed a spherical, subsporangial, intramatrix swelling about  $8\text{--}10\ \mu$  in diameter. From the base of the latter body, rhizoids emanated and ramified through one or more cells of the host (TEXT FIG. 3, B). Zoöspores were produced in the same manner as that described for the resting spores. In this process the content of both intra- and extramatrix parts of the sporangium was discharged.

Although Scherffel has placed this form in *Chytridium*, with

which it is more nearly related, the method of zoöspore formation is somewhat different from that encountered in a species such as *C. Olla*. The partial organization of the zoöspores within the sporangium followed by the final cleavage after emergence is *Rhizidium*-like in its features. However, the presence of an operculum and of an intramatrical resting spore distinguishes it as a *Chytridium*. Perhaps in the future, when more material of this and related forms is observed, it will be found advisable to segregate *C. Schenkii* from this genus. Such a course, the writer feels, would further clarify generic concepts in this group.

Parasitic in *Oedogonium* spp., Fish Hatchery, 1928; Waverley, Mass., 1929.

RHIZIDIOMYCES APOPHYSATUS Zopf, Nova Acta Akad. Leop.-Carol. 47: 188. 1884.

Sporangia extramatrical, ovoid to globose, 12–18  $\mu$  in diameter, with a well defined, broad discharge tube; possessing an intramatrical, subsporangial portion, spherical, about 3.5  $\mu$  in diameter, but varying with the size of the extramatrical part. From the subsporangial swelling a system of branched rhizoids arises, which penetrates, the eggs of the fungous host (TEXT FIG. 3, M). The undifferentiated sporangial protoplasm is ejected into a vesicle formed at the apex of the discharge tube and is there cleaved into zoöspores. After maturation is completed the latter rupture the vesicle and escape. A few of these spores, which are about 3  $\mu$  in diameter, usually retreat into the sporangium and may remain active there a long time. The zoöspore, upon coming to rest on an oögonium of a fungus, in this case, *Achlya*, produces a needle-like penetration tube which pierces the host wall, and, within, enlarges to a knob-shaped body (TEXT FIG. 3, I). From the latter structure, the apophysis, there is produced a rhizoidal system which branches and rebranches within the oögonium, the tips penetrating the eggs of the host. Further growth involves the enlargement of the extra- and intramatrical portions, as well as the elongation and ramification of the rhizoids. As the sporangium matures, a discharge tube is formed, through which the protoplasm of the whole plant is ultimately discharged.

Parasitic in *Achlya* sp. (?), Fish Hatchery, 1929; North Carolina (Coker).

DIPLOPHLYCTIS INTESTINA (Schenk) Schröter, l.c. p. 78.

*Rhizidium intestinum* Schenk, pro. parte, l.c., figs. 1-9. 1858.

This is one of the most common and most striking of all of the chytrids and may usually be found in most dead plants of *Nitella*. The sporangia (TEXT FIG. 2, J), which are intramatrical, consist of a globular portion, varying greatly in size (usually about  $25\ \mu$  in diameter), and a subsporangial apophysis. The latter is variable in size but is usually about one-half the diameter of the sporangium. From the apophysis there is produced a richly branched system of rhizoids which may ramify extensively throughout the host cell. The sporangium discharges its fully formed zoöspores to the outside of the host cell by means of a tube of variable length.

Resting spores are abundantly formed and are similar to the sporangia in their main features (TEXT FIG. 2, E). The wall of the spore is thick, dark brown, and beset with numerous slender spines. These resting spores vary greatly in size, but in the present material are  $10\text{--}26\ \mu$  in diameter. The apophysis varies from  $2.7\text{--}5.2\ \mu$  in diameter.

Details of the morphology and life history of this organism have been recently described by Karling (15).

Saprophytic on dead cells of *Nitella flexilis*, Fish Hatchery, 1926-30. *Nitella* and *Chara*, New York (?) (Karling).

HARPOCHYTRIUM HEDENII Wille, Petermann's Mitt. Erg. 131: 371. 1900.

*Rhabdium acutum* Dang., Ann. Myc. 1: 61. 1903.

*Fulminaria Hedenii* Wille, Nyt. Mag. f. Naturvidenskab. 41: 175. 1903.

This fungus was first called to the writer's attention by Dr. A. W. Blizzard, who found it on filaments of *Oedogonium*, collected in the vicinity of the Laboratory. Subsequently, the writer found other material, not only on this alga, but on *Spirogyra* as well.

On both algae the sporangia were markedly curved and resembled slender sickles. Those on *Oedogonium* varied from

13–50  $\mu$  in length by 2–2.6  $\mu$  in diameter (TEXT FIG. 2, H), while on *Spirogyra* they were about 31  $\mu$  long by 2  $\mu$  in diameter (TEXT FIG. 2, I). The tips of the basal, sterile portions of the sporangia, which partially penetrated the walls of the host, were not expanded, as has been described for other plants of this species, but were blunt and peg-like in appearance. No proliferation of the sporangia was observed.

This genus has been discussed in detail by Atkinson (1, 2) and more recently by Graff (12).

On *Oedogonium* and *Spirogyra* spp., Fish Hatchery, 1928; New York (Atkinson); Montana (Graff).

#### FAM. CLADOCHYTRIACEAE

CATENARIA ANGUILLULAE Sorokin, Ann. Sci. Nat. VI. 4: 67. 1876.

This interesting member of the Cladochytriaceae was found in the shell of a species of rotifer (*Monostyla*?). Whether or not it was parasitic could not be determined. The sporangia were irregularly ovoid, flask-shaped structures, connected to one another by a septate mycelium about 2  $\mu$  in diameter (TEXT FIG. 4, H). Extremely delicate rhizoids were apparent emanating from this mycelium, as well as from the sporangia. The latter structures were from 15.6–26.3  $\mu$  in length by 13–15.6  $\mu$  in diameter. The zoöspores were formed within the sporangium and were discharged successively through a tube, 2.7  $\mu$  in diameter and of variable length, to the outside of the body of the host. They were spherical, 2  $\mu$  in diameter, with a single cilium and one or often two oil globules. With respect to size, these spores agree more nearly with those of Sorokin's fungus (1.5–2  $\mu$ ) than with those reported by Butler (5) (6.5–7.5  $\mu$   $\times$  4–4.5  $\mu$ ).

This seems to be the first record of this fungus occurring on a mature rotifer. Butler's recent paper (l.c.) gives a good account of the fungus as it occurs on rotifer eggs, and also summarizes the literature.

Parasitic (?) in mature rotifer, Second Lake, 1928.

CLADOCHYTRIUM NOWAKOWSKII Sparrow, Am. Jour. Bot. 18: 615, 1931.

This species (TEXT FIG. 4, F) has been described by the writer in a previous paper (l.c.). It closely resembles *C. replicatum* Karling (Am. Jour. Bot. 18: 526. 1931) to which it ultimately may be referable. Both species resemble *C. polystomum* Zopf (l.c. PL. 21, FIGS. 1-11, explanation p. 234, no description in text). However, since Zopf observed no asexual reproduction it is impossible to tell what he had and his species should be disregarded.

Parasitic in *Spirogyra* sp.(?), *Oedogonium* spp.(?) and *Coleochaete* sp.(?), Fisch Hatchery, 1928; Hanover, N. H., 1931.

**Physocladia** Sparrow, gen. nov.

Mycelium extensive, branched; variable in character; possessing septate turbinate cells, as well as large, non-septate, fusiform to irregular swellings. Sporangia with apophyses; proliferating. Zoöspores uniciliate; completely formed within the sporangium; liberated through a pore after the deliquescence of a papilla, into a well defined vesicle, where they swarm for a period before rupturing this structure and escaping; upon germination, giving rise to an extensive mycelium bearing the sporangia and resting spores.

Mycelio copioso, ramoso, irregolari, extramatrixali. Sporangio apophysisibus munito, proliferante, papilla (non operculo) munito. Zoösporibus 1-ciliatis, exeuntibus in vesicam. Sporibus perdurantibus crassiuscule tunicatis, extramatrixalis.

The specific description of *N. obscura* has been given in a former paper (28).

**Physocladia obscura** Sparrow, comb. nov. (TEXT FIG. 4, E).

?*Nowakowskiella obscura* Sparrow, Am. Jour. Bot. 18: 619. 1931.

A detailed description of this fungus has been given in a recent paper by the writer (28). Because of the obvious similarity in habit and in the resting spores to *Nowakowskiella*, the fungus was tentatively assigned to that genus. However, since the aforementioned paper was written, the writer has had an opportunity to examine an abundance of material of *Nowakowskiella elegans*, collected at Hanover, N. H., and has been able to compare the non-sexual reproduction of the two organisms. It was at

first supposed that the method of non-sexual reproduction of *Nowakowskiella* would be sufficiently variable to include the Cold Spring Harbor fungus in this genus. However, after critically examining zoospore production in *Nowakowskiella* under varying conditions, it has been found that this process is remarkably stable in its main features. An operculum is always thrown off, enabling the zoospores to slip out of the sporangium,

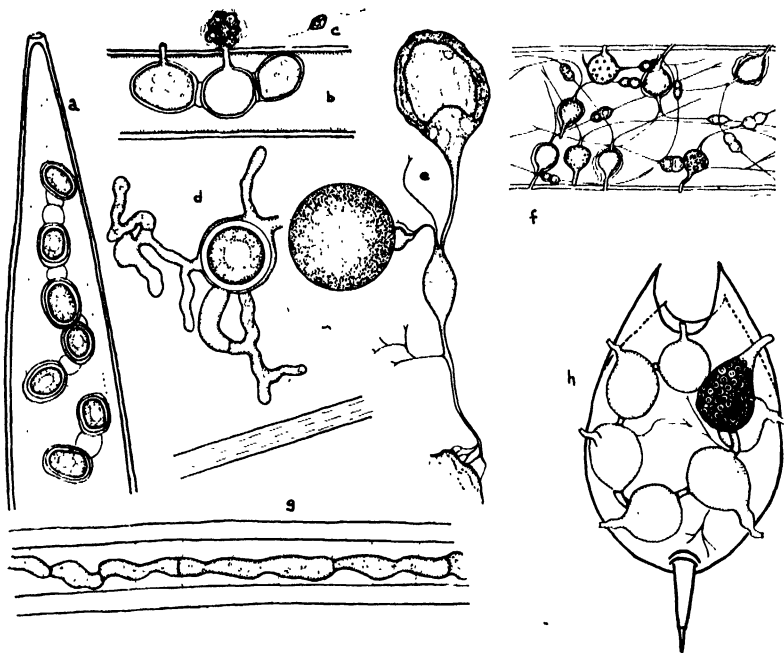


FIG. 4. (a) *Myzocytiium proliferum*. Resting spores in *Closterium* ( $\times 200$ ). (b) Sporangia and zoospore formation of same fungus in *Mougeotia* ( $\times 365$ ). (c) Zoospore of same fungus ( $\times 365$ ). (d) *Lagenidium Rubenhorstii*. Mature oospore, antheridium and portion of thallus in *Spirogyra* ( $\times 670$ ). (e) *Physocladia obscura*. Habit of plant on pollen grain, showing immature and proliferated sporangia ( $\times 360$ ). (f) *Cladochytrium Nowakowskii*. Portion of a cell of *Spirogyra* infected by the fungus ( $\times 175$ ). (g) *Reticularia nodosa*. Portion of thallus in *Tolypothrix* ( $\times 760$ ). (h) *Calenaria Anguillulae*. Sporangia in *Rotifer* ( $\times 370$ ).

surrounded or imbedded in "slime." At the mouth of the sporangium they remain motionless for a time, ultimately bursting apart and swimming away. No instances of zoospores swimming actively out of the sporangium into a rigid, flask-

shaped vesicle after the deliquescence of a papilla were observed. This, it will be recalled, was the typical method of zoöspore discharge in the form termed *P. obscura*. In this respect, the latter fungus resembles to a degree *Physoderma maculare*, as described by Clinton (6). However, the method of development, resting spores, and general habit of the organism under discussion differ markedly from *Physoderma*, and the latter need not be considered in this connection.

The characters in which the present fungus differs from *Cladochytrium* and *Nowakowskiella*, as well as those in which it is similar, are summarized in the following table.

TABLE 1

COMPARISON OF *Cladochytrium*, *Nowakowskiella* AND *Physocladia*

<i>Cladochytrium</i>	<i>Nowakowskiella</i>	<i>Physocladia</i>
1. Zoöspores emitted by gelatinization of apex of a discharge tube, which is always formed	1. Zoöspores emitted after dehiscence of an operculum. Discharge tube not usually formed	1. Zoöspores emitted by gelatinization of a papilla. No discharge tube
2. Zoöspores a motionless mass at the mouth of the tube, surrounded by a slime coat	2. Zoöspores a motionless mass, surrounded by slime, at mouth of sporangium	2. Zoöspores an actively swarming mass, confined in a definite vesicle
3. Zoöspores liberated by the swelling of the spores, which bursts slime coat	3. Zoöspores liberated as in <i>Cladochytrium</i>	3. Zoöspores liberated by rupture of vesicle wall by one or more swimmers
4. Resting spores not known	4. Resting spores borne on the extramatrical mycelium; spherical, thick-walled	4. Resting spores as in <i>Nowakowskiella</i>
5. Habit of plant usually intramatrical; tenuous, saprophytic or parasitic	5. Habit of plant extramatrical, larger than <i>Cladochytrium</i> . Saprophyte	5. Habit of plant as in <i>Nowakowskiella</i> . Saprophyte

Although the Cold Spring Harbor organism<sup>2</sup> possesses close affinities with *Nowakowskiella* and *Cladochytrium*, in the light of our present knowledge, and if a sharp delimitation of genera is to be maintained, it seems more desirable to segregate the fungus in a new genus, than to attempt to include it in any previously described one. The foregoing generic diagnosis is therefore included.

<sup>2</sup> In its habit rough-walled resting spore and vesicle this fungus is quite similar to the problematical *Zygochytrium aurantiacum* Sorokin (25).



## ANCYLISTALES

## FAM. ANCYLISTACEAE

MYZOCYTIUM PROLIFERUM Schenk, l.c. p. 10. 1858.

*Pythium proliferum* Schenk, Verh. Phys.-Med. Ges. Würzb. 9: 20. 1857 (Not *Pythium proliferum* deBary).

*Pythium globosum* Walz, Bot. Zeit. 1870: 554, pro parte.

*Pythium globosum* Schenk, Verh. Phys.-Med. etc., p. 25. 1857.

*Lagenidium globosum* Lindstedt, Synopsis d. Saprolegnieen, p. 54. 1872.

The link-like mycelium of this fungus has been found a number of times on various members of the Conjugatae, and the species is apparently a common one. The mature, unbranched thallus, which consisted of 1–6 spherical to ellipsoidal links, about  $15.7\ \mu$  long by  $13\ \mu$  in diameter, possessed a finely granular content in which were imbedded the characteristic, highly refractive granules similar to those found in other members of the order.

Discharge of the zoöspores was observed in many instances. From each link of the thallus, now invested with a definite wall which separated it from the adjoining portion, there was developed a tube, about  $2\ \mu$  in diameter, which pierced the host wall (TEXT FIG. 4, B) and through which the protoplasm of the fungus was discharged to the outside. There, surrounded by an exceedingly tenuous vesicle, maturation of the zoöspores took place in a manner entirely similar to that of *Pythium*. The zoöspores were of the typical laterally biciliate type (TEXT FIG. 4, c),  $5.4\ \mu$  in length by  $3.6\ \mu$  in width.

Sexual reproduction was observed in only a few instances. This involved the discharge of the protoplasm of one, more narrow cell through a short, laterally placed tube into an adjoining, more spherical cell. In the latter, there was subsequently formed a spherical, thick-walled "oöspore,"  $10\text{--}25\ \mu$  in diameter, which never completely filled the "oögonium." Ellipsoid, more angular spores,  $18\text{--}27\ \mu$  in diameter, were found in *Closterium acerosum* (TEXT FIG. 4, A).

Parasitic in *Mougeotia* sp. (?) and *Closterium acerosum*, Second Lake, 1928–30; Hanover, N. H., 1930–31; Iowa (Martin); Montana (Graff).

LAGENIDIUM RABENHORSTII Zopf, Sitz.-ber. Bot. Ver. Brand.  
20: 77. 1878.

This fungus has been observed a number of times on various species of *Spirogyra*. The sparingly branched thallus of limited extent, which consisted of hyphae  $2.6\text{--}5\ \mu$  in diameter, was slightly constricted wherever the irregularly placed cross walls occurred.

Zoöspore formation took place in the same manner as that described for *Myzocyttium*. The protoplasm of a hyphal segment was discharged through a tube to the outside of the host and there, within a vesicle, was cleaved into zoöspores. The latter were similar to those of *Myzocyttium*. The sex organs were more highly developed than those of the last named genus and closely resembled types found in *Pythium*. The antheridium was of a crooknecked type,  $15\ \mu$  long by  $5\ \mu$  in diameter, and was separated from the rest of the hypha by a cross wall. The oogonium, which occurred on the same hypha as the antheridium, was spherical, and about  $15\ \mu$  in diameter. After fertilization, during which there was a passage of antheridial protoplasm through a tube into the oogonium, there was formed a thick-walled oöspore, about  $10.4\text{--}13\ \mu$  in diameter (TEXT FIG. 4, D).

Parasitic in *Spirogyra* spp., Fish Hatchery, 1928--30; Cambridge, Mass., 1928; New York (Atkinson); Montana (Graff).

(?) RESTICULARIA NODOSA Dangeard, Le Botaniste 2: 96. 1890-91.

The irregular thallus of what is possibly this fungus was found on *Tolypothrix* (TEXT FIG. 4, G). The mycelium was unbranched and constricted at irregular intervals. Occasional cross walls were present, but were not found in all instances where the hyphal constrictions occurred (TEXT FIG. 4, G). No reproductive organs were observed and hence the writer can add nothing to our scanty knowledge of this form. From the shape of the thallus and its habitat, however, there is a strong possibility that this is the mycelium of *Resticularia*.

Parasitic in *Tolypothrix* sp. (?), Fish Hatchery, 1928; Cambridge, Mass., 1927.

## MONOBLEPHARIDALES

## MONOBLEPHARIDACEAE

MONOBLEPHARIS SPHAERICA Cornu, Ann. Sci. Nat. V. 15: 82. 1872.

The mycelium of this fungus, which is  $3-8\ \mu$  in diameter, is characterized, as are all other members of the order, by a peculiar, reticulate, or foamy disposition of the protoplasm (PLATE 7, F).

In its sexual apparatus, this species is readily distinguished from other members of the genus. The antheridia, which are  $10-20\ \mu$  long by  $5\ \mu$  in diameter, are always formed just beneath the oögonium (PLATE 1, F). In the antheridium there is formed a varying number of unciliate sperm, which upon maturity creep out of the former structure in an amoeboid fashion. Ultimately, one of these may come to rest on the apical receptive papilla of the oögonium. The sperm immediately sinks into the egg cell and is soon completely absorbed. After a few minutes, the fertilized egg emerges from the oögonium and there it ultimately becomes invested with a thick, brown, bullate wall. These oöspores vary from  $15-20\ \mu$  in diameter. A type of endogenous "chlamydospore" similar to those figured by Woronin (29) for this species was observed in numerous instances.

Further details of this and other species of *Monoblepharis* are reserved for a future paper on this whole group, which the writer has in preparation.

Saprophytic on twigs of *Betula*, spring, near Second Lake, 1929; Waverley, Mass., 1928-29; Hanover, N. H., 1930; Mt. Holly, Pa., 1931.

GONOPODYA POLYMORPHA Thaxter, Bot. Gaz. 20: 481. 1895.

The filamentous, sparingly branched thallus of this species is usually constricted at irregular intervals where hyaline, pseudo-septae occur (PLATE 7, L). The hyphae, which are  $2.5-5.2\ \mu$  in diameter, exhibit a foamy, sometimes reticulate protoplasmic structure, similar to that found in *Monoblepharis*. Near the ends of the branches the tufted hyphal segments become more spherical, and on these, ovate sporangia are formed. The latter vary from  $18-52\ \mu$  in length, by  $18-36\ \mu$  in diameter. A

variable number of somewhat cylindrical zoöspores,  $10\ \mu$  long by  $5\text{--}8\ \mu$  in diameter, are formed in each sporangium. At maturity, these emerge in an amoeboid manner from the apex of the sporangium. The zoöspores are uniciliate, and seem to have the same internal structure as the zoöspores and sperm of *Monoblepharis*. After discharge of the zoöspores the sporangia may often proliferate.

Saprophytic on twigs of various types, and on apples, Fish Hatchery, *Sphagnum* bog, Second Lake, 1927–28; Belmont, Mass., Cambridge, Mass., 1927–29; Hanover, N. H., 1930; Cambridge, Mass., Maine (Thaxter).

GONOPODYA SILIQUAEFORMIS (Reinsch) Thaxter, l.c. p. 480.

*Saprolegnia siliquaeformis*, Reinsch, Jahrb. Wiss. Bot. 11: 293. 1876.

*Gonopodya prolifera* Fischer, l.c. p. 382. 1892.

The distinguishing feature of *G. siliquaeformis* is its long, tapering, pod-like sporangia (PLATE 7, A), and the profusely branched mycelium. The sporangia vary greatly in their dimensions, in the Cold Spring Harbor material being  $52\text{--}59\ \mu$  long by  $20\text{--}23\ \mu$  at greatest diameter. These measurements are considerably smaller than those given by Thaxter and Kanouse (14) ( $130\text{--}250\ \mu \times 22\text{--}30\ \mu$ ). However, in material collected at Cambridge, Mass., which cannot otherwise be distinguished from the present material, the dimensions easily approximated those given by the aforementioned investigators. In fact, in a single pustule one may sometimes find sporangia of all sizes, and varying in shape from a polymorpha to a siliquaeformis type. This species, in contrast to *G. polymorpha*, is usually found under foul conditions of environment. When so growing, the walls of the sporangia often are colored a yellow-brown.

Saprophytic on twigs and apples, Fish Hatchery, 1928–29; Cambridge, Mass., 1928–30; Mt. Holly, Pa., 1931; Maine, Mass. (Thaxter); Michigan (Kanouse).

## BLASTOCLADIALES

### BLASTOCLADIACEAE

BLASTOCLADIA PRINGSHEIMII Reinsch, Jahrb. Wiss. Bot. 11: 298. 1878. Amend. Thaxter, Bot. Gaz. 21: 51. 1896.

Plant body consisting of a large basal cell, which varies greatly in size, in the present material attaining a length of  $130\ \mu$ , and a diameter varying from  $10\text{--}26\ \mu$  in the cylindrical to tapering, basal, trunk-like portion, to  $25\text{--}52\ \mu$  in the expanded, distal part (PLATE 7, H). On the latter region of the thallus are placed the cylindrical sporangia. These are quite variable in size, although the smaller sporangia are usually found on the smaller plants. In the Cold Spring Harbor material the sporangia are  $53\text{--}62\ \mu$  in length by  $7.8\text{--}18\ \mu$  in diameter. Long setae are frequently present on the plants, although they are not always found. The lower portion of the basal cell terminates in a series of branched, root-like rhizoids, which penetrate the substratum. The content of the basal cell is often characterized by the presence of large, irregularly shaped refractive oil globules which lend a distinctive appearance to the plant.

Zoöspores are completely formed within the sporangium and escape, according to Thaxter (l.c.) and Kanouse (14), singly, without the formation of a vesicle. However, in material of this species obtained at Hanover, N. H., a type of zoöspore discharge similar to that described by Minden in 1916 (21, p. 193) was observed. During cleavage of the spores within the sporangium, a sharply defined apical cap (PLATE 7, C) was formed, from the under side of which a peg-like structure protruded. Upon the emergence of the zoöspores, the peg disappeared, and the cap was carried up with the mass of spores (PLATE 7, D). The latter were surrounded by a definite membrane which held the spores in a cylindrical column. When the column of spores nearly equaled the sporangium in length, the membrane broke, the cap disappeared from view and the spores continued on through the mass of scum and bacteria surrounding them, maintaining clumps of four or eight, yet tending to separate and swim away by their own motility (PLATE 7, E). Save for the greater length of the spore column, this account is essentially the same as that described by Minden for this species. In material that has recently been collected of this species, a similar mode of discharge was observed, save that the vesicle was ruptured somewhat earlier. It is probable that the formation and subsequent extent of development of the vesicle is dependent, in this form,

on how favorable conditions are for zoöspore discharge. Under "optimum" conditions of temperature, as defined by Cotner (8) for this species, the aforementioned type of zoöspore discharge has always been observed to take place.

No resting spores were found in the Cold Spring Harbor material, but these have been observed in abundance in recently collected material. Whether or not in the first instance we were dealing with gamete-bearing plants or ones wholly non-sexual, as might be anticipated from Kniep's work on *Allomyces* a closely related genus (17), was not determined.

On apple, Fish Hatchery, 1927; Belmont, Mass., 1928; Hanover, N. H., 1931; Cambridge, Mass., Maine (Thaxter); Michigan (Kanouse).

*BLASTOCLADIA RAMOSA* Thaxter, l.c. p. 50.

Specimens of *B. ramosa* were found in the same pustules as the preceding species (PLATE 8, J). Discharged sporangia, 30  $\mu$  long by 12  $\mu$  in diameter, and thin-walled, spatulate, resting spores, 25  $\mu$  long by 10–12  $\mu$  in diameter, were found. The whole plant was characterized by an open, ramose habit, and narrowly cylindrical basal cell.

Maine (Thaxter); Montana (Graff).

***Blastocladia truncata*** Sparrow, sp. nov.

Basal cell narrowly cylindrical, unbranched, slightly expanded at the top; 250–286  $\mu$  in length by 7.7–26  $\mu$  in diameter; possessing a slightly branched rhizoidal system. Sporangia truncate, nearly as broad as long, 10.4–15  $\mu$  long by 10.4–12  $\mu$  in diameter. Plant without setae. Zoöspores 3.5  $\mu$  in diameter. Resting spores not observed.

Cellula basali anguste cylindracea, irramosa, paulum ad apicem dilatata, sine setis; 250–286  $\mu$  long., 7.7–26  $\mu$  dia.; rhizoidibus paulo ramosis. Sporangii truncatis, 10.4–15  $\mu$  long., 10.4–12  $\mu$  dia. Zoösporibus 3.5  $\mu$  dia. Sporibus perdurantibus non perspectis.

Hab. in fructibus mali in aqua.

This plant has been observed in several instances and does not seem to be simply a form of *B. Pringsheimii*. It is distinct from other described species by the shape of the sporangia. Before discharge, these are distinctly truncated at both apex and base,

but after ejection of the zoöspores, appear more tapering (PLATE 7, G).

Saprophytic on apple, Fish Hatchery, 1927.

## LEPTOMITALES

### LEPTOMITACEAE

*SAPROMYCES REINSCHII* (Schröter) Fritsch, Oesterr. Bot. Zeits. **43**: 420. 1893.

*Hyphomycetarium* Reinsch, Contr. Algol. & Fungol. **1**: 1875.

*Naegelia* Reinsch, Jahrb. Wiss. Bot. **11**: 298. 1878.

*Naegeliella Reinschii* Schröter, l.c. p. 103.

*Sapromyces dubius* Fritsch, l.c.

*Rhipidium elongatum* Cornu, Ann. Sci. Nat. V. **15**: 15. 1872.

From a narrow basal cell attached by rhizoids to the substratum, the long secondary axes of the fungus arise. These, by further branching, form a thallus which in some instances may attain a length of over 1000  $\mu$  (PLATE 7, J). The segments of the body are delimited by constrictions with pseudo-septa. At the junctures of the segments, whorls of narrowly cylindrical sporangia, about 50  $\mu$  long by 10–15  $\mu$  in diameter, arise.

The sex organs of this species are characterized by the fact that the male and female organs are found on different plants. Preliminary experiments by P. H. Jordan, soon to be published, seem to indicate that this species is heterothallic. Spherical to pyriform oogonia arise from short, constricted branches formed in the same position on the axis as the sporangia. The antheridia are irregular, expanded bodies formed at the termini of long, twisted hyphae. They are usually found attached to the upper part of the oogonium (PLATE 1, K).

The oöspore is spherical, about 20  $\mu$  in diameter, with a slightly irregular, thick, dark wall. The content of this spore usually possesses a single oil globule. During maturation of the oöspore, the outer wall of the oogonium becomes a dark brown color, and is usually somewhat roughened by this "incrustation."

Saprophytic on twigs of various sorts, spring near Third Lake, 1928; Cape Ann, Mass., 1926; Arlington, Mass., 1928; Maine (Thaxter); ?North Carolina (Couch), a sterile form; Montana (Graff).

SAPROMYCES ANDROGYNUS Thaxter, Bot. Gaz. 21: 329. 1896.

The general habit of the plant, although not so extensive, is similar to the preceding species (PLATE 7, B). Sporangia are borne in the same manner and are about the same size as those of *S. Reinschii*. The sex organs of the two are different with respect to the origin of the antheridia. In contrast to *S. Reinschii*, the antheridium of this species is androgynous in origin, and arises from a short hyphal outgrowth just below the oögonial stalk (PLATE 7, I). The distal portion of the male organ is usually attached to the top of the oögonium. Occasionally, twists in the antheridial filaments, similar to those figured by Thaxter, were observed. The oögonia were usually about 30  $\mu$  in diameter and the mature oöspores, similar in appearance to those of *S. Reinschii*, were about 15–20  $\mu$  in diameter. The darkening of the oögonium wall, noticeable in the last mentioned species, was not observed in this material of *S. androgynus*, although Thaxter described it as occurring in his material.

Saprophytic on *Fraxinus* twigs, First Lake, 1929; Arlington, Mass., 1928; vicinity of Cambridge, Mass. (Thaxter).

APODACHLYA PYRIFERA Zopf, Nova Acta Acad. Leop-Carol. 52: 362. 1888.

*Leptomitus pyriferus* Zopf, Die Pilze, Schenk's Handbuch 4: 299. 1890.

A common inhabitant of twigs in cold water. The sparingly branched hyphae are constricted at intervals of 130–185  $\mu$ , and possess a finely granular, somewhat hyaline content in which are occasional refractive granules ("cellulin"). Pyriform to spherical sporangia, about 44  $\mu$  long by 14–22  $\mu$  in diameter, are borne either terminally or laterally on the hyphae. The spores are cleaved out within the sporangium, and, after being discharged successively from the latter body, form a motionless, irregular mass at the mouth of the apical, sporangial pore. These cysts, 4–8 in number, measure about 11  $\mu$  in diameter. After a varying length of time, there emerges from each cyst a motile zoöspore of the "secondary," biciliate type. No resting spores were observed in the present material.

Saprophytic on twigs of *Fraxinus*, First Lake, 1927; Arlington, Mass., 1928.



*Apodachlya brachynema* (Hildebr.) Pringsheim, Ber. Deuts. Bot. Ges. 1: 289. 1883.

*Leptomitus brachynema* Hildebrand, Jahrb. Wiss. Bot. 6: 261. 1867.

*Apodya brachynema* (Hildebr.) Cornu, Ann. Sci. Nat. V. 15: 14. 1872.

This seems an even more common plant than the preceding one, and is often found on decaying apples in water. The thallus is characterized by the production of moniliform cells, varying from  $11.2\text{--}29.6\ \mu$  in diameter, sometimes spherical, or more often, 2–3 times as long as wide. The spherical resting spores are borne terminally and vary from  $25\text{--}33\ \mu$  in diameter. They possess a definite wall, about  $1.5\text{--}2\ \mu$  in thickness, which is distinct from the "oögonial" wall. Passage of protoplasm from the moniliform cell immediately below the "oögonium" has been observed a number of times. No sporangia were found, but the moniliform cells and the lack of punctations on the resting spore serve to distinguish it from the previously described species and *A. punctata* Minden.

Saprophytic on apples and twigs, Fish Hatchery, 1928–29; Arlington, Mass., 1928; North Carolina (Coker); Massachusetts (Thaxter); Michigan (Kanouse); Mississippi, Wisconsin (Harvey).

*ARAIOSPORA PULCHRA* Thaxter, Bot. Gaz. 21: 328. 1896.

This exquisite plant was found only once at Cold Spring Harbor, but was collected in abundance in Massachusetts. The stout basal cell with its rhizoids is about  $50\text{--}80\ \mu$  in diameter, and may attain a length of  $800\text{--}1000\ \mu$  (PLATE 8, F). Its cylindrical, apical region is much branched, and on these hyphae the reproductive organs are borne.

In this genus, sporangia of two kinds are formed. One type is similar to that found in *Sapromyces*, while the other may be more spherical and furnished with spines. In the present species, according to Thaxter, the spines are usually stout, radiating in all directions, and generally disposed over the whole sporangium. In *A. coronata* Linder (18), they form an apical crown of short incurved prongs around the papilla of discharge. Sporangia of the spiny type were not seen in the Cold Spring

Harbor material, nor were they found in the Massachusetts collection. In both instances, only the cylindrical, smooth-walled ones were observed.

The sexual reproduction of this species, especially the structure and development of the oöspore, is of unusual interest. As it has been described in detail by Thaxter (l.c.) and King (16), there is no need to include it here. The pedicellate oöspores, which at maturity are 30–50  $\mu$  in diameter, possess not only the usual thickened wall found in other members of this group, but, in addition, a peripheral layer of hexagonal cells which King (l.c.) has shown arises from the periplasm. The whole oöspore completely fills the oögonium (PLATE 8, G). The tortuous antheridial branches generally arise from the same stalk as the oögonium, and the distal, expanded portion, which is cut off from the rest of the hypha, is ordinarily applied near the base of the oögonium.

Saprophytic on twigs of *Fraxinus*, First Lake, 1929; Arlington, Mass., 1928; Cambridge, Mass., 1928; Massachusetts, Maine (Thaxter); Mass. (King).

RHIPIDIUM AMERICANUM Thaxter, l.c. p. 327.

In its main features, the thallus of *Rhipidium* resembles that of *Blastocladia*. The distal portion may, however, be more elaborate and gnarled than is found in the latter fungus. Often the cylindrical, trunk-like portion is not developed, and the rhizoids arise directly from the expanded upper portion. In either case, from the latter region sporangia arise, either terminally on short, constricted pedicels, or sympodially on longer filaments (PLATE 8, A). These sporangia, which vary greatly in size, are ovoid to sub-cylindrical in shape. Details of zoöspore production are described by Thaxter (l.c.).

The sex organs are usually terminally placed on the filaments. The spherical oögonium varies from 33.6–42  $\mu$  in diameter, and, after fertilization by the androgynous antheridium (PLATE 8, B), there is produced within it an oöspore, the golden exospore of which is elevated in a series of irregular ridges (PLATE 8, B). This oöspore never fills the oögonium, and varies from 28.4–33.6  $\mu$  in diameter.

Variations in the shape and size of the thallus of this plant are

quite remarkable. The peltate specimens described above may be 80–100  $\mu$  in breadth, while the cylindrical axis of the tree-like forms may attain a length of 300–900  $\mu$  before expanding. The rhizoidal system is also variable in its extent; it is much more developed than that of *Blastocladia*, and may often possess numerous spherical swellings along its many branches.

Saprophytic on Apple, Fish Hatchery, 1927–29; Belmont, Mass., 1928; Cambridge, Mass., 1928; Maine, Mass. (Thaxter); Michigan (Kanouse).

## SAPROLEGNIALES

### SAPROLEGNACEAE

APHANOMYCES PARASITICUS Coker, The Saprolegniaceae, with notes on other water molds, 201 pp., 63 pls., p. 165. 1923.

The broad hyphae and dark, spiny oögonia of this species have been found in two instances, both times parasitic in filaments of *Achlya* spp.(?). The hyphae are 5–7  $\mu$  in diameter, and, in badly parasitized filaments of the host, may almost completely fill the latter structures (PLATE 8, c). The relationship of the sex organs to each other could not be determined with certainty in the cases observed, due to the crowded conditions within the *Achlya* filaments. Coker states that the large antheridia are declinous in origin. At maturity, the oöspore lies within an oögonium which possesses a dark wall beset with sharp, gradually attenuated spines, 5–8  $\mu$  in length. No sporangia were observed, but from the close agreement of this plant in all other respects with Coker's species, we have no hesitancy in so naming it.

Parasitic in filaments of *Achlya* spp.(?), Jarvis Pool, 1929; Arlington, Mass., 1928; North Carolina (Coker, Couch, Raper).

APHANOMYCES PHYCOPHILUS deBary, Jahrb. Wiss. Bot. 2: 179. 1860.

An account of this fungus has been given in a previous paper by the writer (27).

Parasitic in *Nitella flexilis*, Fish Hatchery, 1929; Maine (Thaxter); Indiana (Weatherwax); Michigan (Kauffman); North Carolina (Couch).

## PYTHIALES

## PYTHIACEAE

ZOÖPHAGUS INSIDIANS Sommerstorff, Oestr. Bot. Zeits. 61: 361. 1911.

This fungus (PLATE 2, H) has been recently described by the writer (26). No further points of interest were exhibited by the present material.

Parasitic in various members of the *Rotiferae*, Fish Hatchery, 1930; Maine, 1928; Mass. (Weston).

PYTHIOGETON RAMOSUM Minden, Falck, Mykolog. Untersuch. Berichte 1: 238. 1916.

The narrow, pyriform sporangia of this fungus (PLATE 8, I) were found in abundance in twig cultures maintained at room temperature. The tenuous hyphae, about  $3\mu$  in diameter, which formed a tangled mass about the twigs, were less frequently branched than those figured by Minden. The sporangia, while varying somewhat in size and becoming successively smaller as proliferation occurred, were generally about  $60\mu$  in length and tapered from 20 to  $8\mu$  in diameter. The sporangial axis of this species runs at nearly right angles to that of the attendant hypha.

Minden considers this species very close to, if not identical with, *P. transversum* Minden. However, the more narrowly pyriform sporangia, with their attenuated beak and terminal position on the hyphae, would seem to mark *P. ramosum* off from the aforementioned species.

No sexual organs were observed either by Minden or the writer.

Saprophytic on twigs of various kinds, First Lake, Jarvis Pool, 1929; Cambridge, Mass., 1927; Sarnia, Ontario, 1928.

PYTHIUM UNDULATUM Petersen, Ann. Myc. 8: 531. 1910.

*Pythiomorpha undulata* (Pet.) Apinis, Acta Horti Bot. Univ. Latviensis 4: 234. 1930.

The sparingly branched, extensive mycelium is characterized by frequent undulations of the hyphae which compose it (PLATE 8, D, E). The latter are somewhat variable in diameter, but usually measure about  $5-7.4\mu$ . The sporangia are narrowly ovoid, but under foul environmental conditions may assume

various shapes. These bodies are at first terminal, but after the discharge of the undifferentiated content through a narrow beak of varying length into a vesicle where the zoöspores are formed, further hyphal growth usually takes place. This may be either by proliferation (PLATE 8, D) through the old sporangium, or, as is usual under excellent environmental conditions, by sympodial branching (PLATE 8, E). The sporangia vary greatly in size, but usually are 40–45  $\mu$  long by 12–15  $\mu$  in diameter.

On oatmeal agar numerous dark brown, rough-walled chlamydospores, 10–50  $\mu$  in diameter, are formed. Similar bodies have been observed in this species by Dissman (11).

Apinis has placed this fungus in *Pythiomorpha*, and is impressed with its similarity to *Gonopodya*. Aside from a slight superficial resemblance, there is no character either in the mycelium, sporangium, formation or structure of the zoöspores which could relate it to *Gonopodya*. As a genus, *Pythiomorpha* has certain features in its sexual apparatus which mark it off from *Pythium*. As the fungus under discussion apparently does not possess sex organs, and as its non-sexual reproduction is that of a typical *Pythium*, in the broader sense of that generic term, there seems little justification for changing the original binomial.

This fungus was first reported from the United States in 1927, by the writer (Annual Report, The Long Island Biological Association, 1927). It has also recently been described by Matthews (19) from North Carolina. The chlamydospores figured by the last named investigator appear to have smooth, hyaline walls rather than rough, brown ones, as found by Dissmann and the writer.

#### SUMMARY

In this paper forty species of aquatic Phycomycetes are described from the vicinity of Cold Spring Harbor, Long Island, New York.

Of these fungi, fifteen appear to be reported for the first time in this country, five have apparently not been mentioned in the American literature for twenty years or more, and four are seemingly new to science.

In conclusion, the writer wishes to thank the Long Island

Biological Association for the use of the facilities of that institution, Prof. H. M. Fitzpatrick for certain suggestions made by him, and particularly Prof. W. H. Weston, Jr., for his critical reading of the manuscript.

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### EXPLANATION OF PLATES

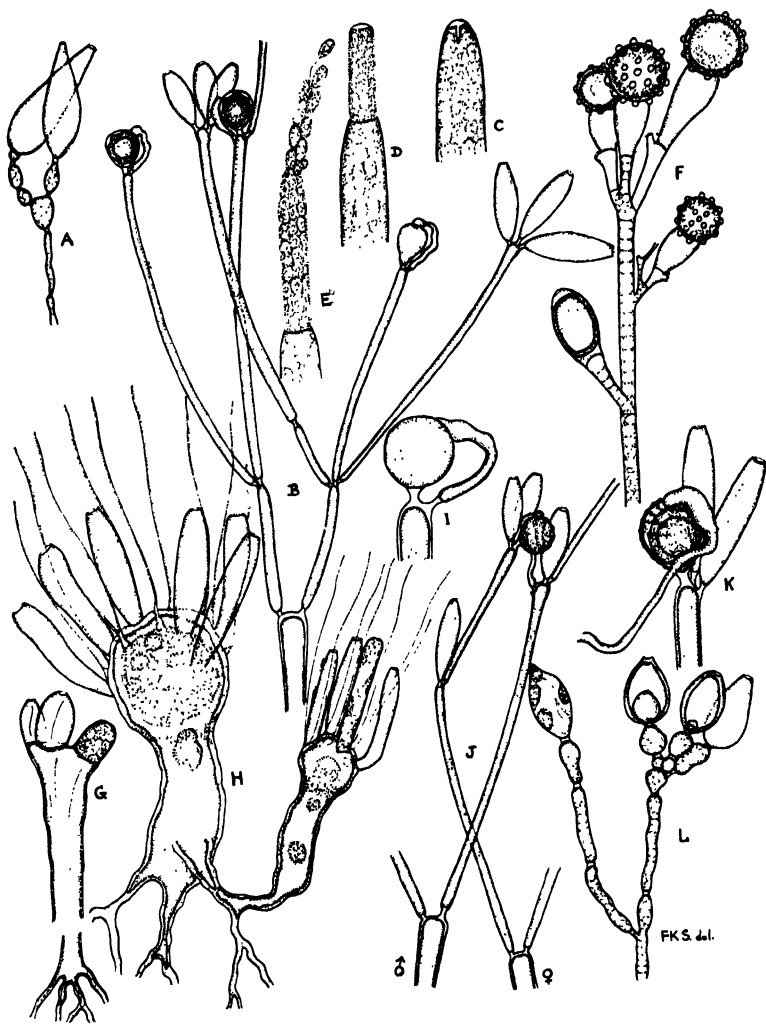
All figures were drawn with the aid of the camera-lucida; the approximate magnifications are given in each instance.

#### PLATE 7

FIG. A. *Gonopodya siliquaeformis*. Portion of a plant with two discharged sporangia.  $\times 250$ ; FIG. B. *Sapromyces androgynus*. Habit of plant showing basal cell and reproductive organs.  $\times 125$ ; FIGS. C, D, E. *Blastocladia Pringsheimii*. Stages in the discharge of the zoöspores.  $\times 270$ ; FIG. F. *Monoblepharis sphaerica*. Sexual organs and an endogenous chlamydospore.  $\times 270$ ; FIG. G. *Blastocladia truncata* n. sp. Plant showing discharged and undischarged truncate sporangia.  $\times 270$ ; FIG. H. *Blastocladia Pringsheimii*. Two plants showing variations in size.  $\times 250$ ; FIG. I. *Sapromyces androgynus*. Detail of relationship of young sex organs.  $\times 250$ ; FIG. J. *Sapromyces Reinschii*. Two plants, one bearing an oogonium, the other, an antheridium. Discharged sporangia also present.  $\times 125$ ; FIG. K. *S. Reinschii*. Detail of relationship of sex organs.  $\times 250$ ; FIG. L. *Gonopodya polymorpha*. Portion of a plant showing proliferated sporangia and zoöspores.  $\times 250$ .

#### PLATE 8

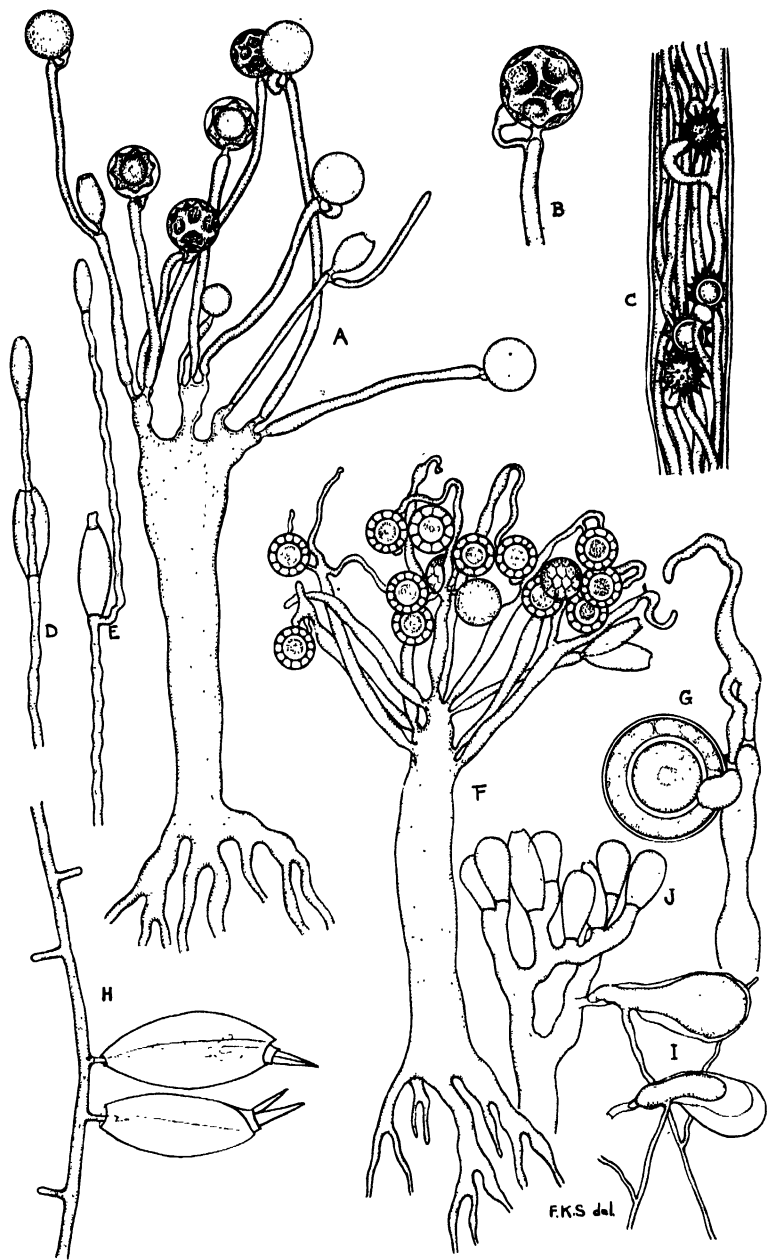
Fig. A. *Rhipidium americanum*. Plant showing discharged sporangia and sex organs.  $\times 125$ ; FIG. B. *R. americanum*. Detail of sexual apparatus showing mature oöspore.  $\times 250$ ; FIG. C. *Aphanomyces parasiticus*. Portion of plant showing mycelium and sex organs in *Achlya* filament.  $\times 250$ ; FIGS. D, E. *Pythium undulatum*. D, showing proliferation of sporangia; E,



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showing sympodial branching.  $\times 250$ ; Fig. F. *Araiospora pulchra*. Habit of plant showing oöspores and smooth sporangia.  $\times 75$ ; Fig. G. *Araiospora pulchra*. Detail of nearly mature oöspore and antheridium in combined views (optical-surface).  $\times 250$ ; Fig. H. *Zoöphagus insidians*. Portion of mycelium showing short, peg-like branches and two rotifers which have been captured by the fungus.  $\times 250$ ; Fig. I. *Pythiogeton ramosum*. Portion of mycelium and two proliferated sporangia.  $\times 250$ ; Fig. J. *Blastocladia ramosa*. Plant bearing thin-walled, spatulate resting spores and discharged sporangia.  $\times 250$ .

## TYPE SPECIMENS OF CERTAIN HYSTERIALES

G. R. BISBY

In a previous paper (1) the writer attempted to summarize the varied views regarding the classification of the Hysteriales, or Hysteriaceae. In order to disentangle the confused nomenclature of these fungi, it is necessary to examine type specimens, most of which are in Europe. The following brief notes deal only with some of the specimens representing names that have been in the literature for many years.

The writer has thus far studied only certain corticolous and lignicolous Hysteriales. Hoehnel (3) proposed limiting the group to the eleven genera partially summarized at the end of this article. This is, however, doubtless too great a limitation. It would seem advisable, for the present at least, to follow the more common usage and include in the Hysteriales several other genera, some of which are folicolous, as has been done by Clements and Shear in their "The Genera of Fungi."

Type specimens and other material have been examined at Kew, the British Museum (Natural History), Berlin, and Paris. Considerable material from other sources has also been seen, and several species have been collected in the field. Notes were taken on the external features of the fruit bodies (hysterothecia), and the minimum amount of type material that would suffice was mounted and the microscopic characters noted. The final compilation of this paper was made at Winnipeg from the data and slides obtained in Europe, and the specimens and literature available here. Many names have had to be left for possible further consideration, and much critical or type material has of course not yet been examined at all.

The modern emphasis upon spore characters has tended to minimize the attention paid to hysterothecial characters in the diagnosis of these fungi. Schweinitz, Fries, and other earlier mycologists based their descriptions almost entirely upon the hysterothecia; but the difficulties of this method may be judged

from the entry below under *Hysterium elongatum*. As a matter of fact, the shape, size, arrangement, polish, and striations of the hysterothecia, the amount of opening of the longitudinal groove, and even the occurrence or amount of subiculum, vary within considerable limits with the nature of the substratum, the growing conditions, and the age or maturity of the specimens. The spores are more constant (provided they are mature), and their septation is especially reliable.

The eleven genera noted at the end of this paper were found (1, p. 186) to include about 300 species names compiled in the first twenty-two volumes of Saccardo's *Sylloge*. Many other species have been described more recently. Ellis and Everhart (2) in 1892 recorded 66 apparently good species in these genera in North America. Rehm (6) and Masee (5) list, however, only 29 and 17 species respectively for the areas they cover. There are certainly many superfluous names, some of which are mentioned below.

Schweinitz (7, 8) collected and named many of these fungi. Shear and Stevens (9) have explained how his specimens come to be in the larger European herbaria. The study of Schweinitz' specimens is necessary in order to understand the American species, and the names to apply to them. There are hundreds of other important specimens in the herbaria visited, only a fraction of which are represented in this account dealing with about eighty-five names.

The interpretation of the species mentioned herein requires that larger compilations (2, 6, 5, Saccardo's *Sylloge*, etc.) be used for supplementary data. The specific names are arranged alphabetically in italics, those that presumably should be discarded are enclosed in brackets; doubtful names are preceded by a question mark; all are summarized at the end of the paper.

*Hysterium abbreviatum* Schw. The specimen at Kew from Schweinitz' herbarium consists of a small piece of wood with a few short hysterothecia, and two fragments of wood without the fungus. The hysterothecia are gregarious, erumpent-superficial amongst and parallel with the fibres of the old wood, about  $\frac{1}{2}$  mm. long, broadly elliptic, black, carbonaceous, not noticeably striate. The asci are cylindric, 8 spored, uniseriate; pa-

raphyses filiform. Spores  $6-8 \times 2-3 \mu$ , hyaline, with one median septum.

Ellis and Everhart (2, p. 682) list "*Hysterium abbreviatum* in Herb. Schw." as a synonym of *Glonium parvulum*. The specimen at Kew is also very evidently *G. parvulum*. Schweinitz' name is much older than that of Gerard, but the latter is in common use and should perhaps be conserved.

*Glonium accumulatum* Schw. The Schweinitz specimens at Kew and the British Museum are *G. stellatum*.

*Hysterium acerinum* Westend. A specimen at Kew "ex herb. Westendorp" is typical *II. pulicare*.

*Hysterium acuminatum* Fries. Type not examined, but Rehm's Ascom. 125 has small spores  $13-16 \times 5-6 \mu$ , 3 septate, uniformly brown. Fuckel's Fungi Rhenani 750 on *Fagus* was found, however, to be typical *II. pulicare*. Rehm (6, p. 15) interprets *II. acuminatum* as a small-spored alpine species on conifers. It is related to *II. pulicare*, especially to *II. angustatum*, but seems sufficiently different in possessing small spores and a coniferous substratum.

"*Hysterium acuminatum* Herb. Schw. 5642" at Kew has brown spores  $16-23 \times 7-8 \mu$ , with 4 to 6 cross septa and one or two longitudinal septa, and a slight median constriction. As Ellis and Everhart stated (2, p. 702) it is a *Hysterographium*, and not the *Hysterium acuminatum* of Fries; they regard it as a synonym of *II. subrugosum*, but the specimen examined at Kew seems to be *H. Mori*.

*Ostreichnion* [*Ostreion*] *americanum* Duby. Type not seen. Ravenel's specimen 1456 from Carolina, which was used by Cooke for illustration in Grevillea 4: pl. 67, fig. 1, has spores up to  $120 \times 35 \mu$ , with as many as 19 septa, end cells often paler, spores sometimes slightly constricted at the center. Massee (5, p. 28) says that the spores are "muriform." There are indications of longitudinal septa in the dark cinnamon brown spores of Ravenel's collection, but they seem to be only pseudo-septa. A specimen from Ravenel at Berlin is the same as that at Kew. Massee (l.c.) reports this fungus for England, but English and continental specimens under the name *O. americanum* Duby at Kew in no case yielded spores resembling the striking

ones found in Ravenel's specimen and in Schweinitz' "*Lophium Sassafra.*"

*Hysterium angustatum* Alb. & Schw. This name refers to the fungus similar to *H. pulicare*, but with spores uniformly brown and somewhat smaller. Rehm (6, pp. 14-15) convinced himself that it is distinct.

[*Hysterium Azaleae* Schw.] One specimen at Kew from Herb. Schw. consists of a split branch of *Azalea* with elongated black structures breaking through the epidermis. No asci or spores were found. Another specimen marked "in Az. nudif. Penn. Michener" has only a thin blackish incrustation in spots on the surface.

?*Hysterium Berengerii* Sacc. A specimen at Kew, "in Fraxino, Treviso, Saccardo," has a few rather large, superficial, sessile, linear, black, carbonaceous hysterothecia, with the ends obtuse, groove conspicuous; spores  $35-40 \times 9-11 \mu$ , dark brown, with 5-8 septa, one cell of the spore commonly larger. The hysterothecia and spores are somewhat larger than in the Schweinitz type of *Hysterium insidens*, but the Saccardo material at Kew agrees well with other American collections that have been considered *H. insidens* (see 2, p. 696).

*Hysterium betulignum* Schw. A specimen at Berlin has spores  $20-22 \times 7-8 \mu$ , 3 septate, with the terminal cells paler. It is *H. pulicare*, as Ellis and Everhart report (2, p. 693) from an examination of the Schweinitz specimen at Philadelphia.

*Hysterium biforme* Fries. The specimen of Fries' Scl. Suec. 329 at Kew has 3-septate spores  $27-34 \times 6-8 \mu$ , with the end cells slightly paler. This is *H. pulicare*. The specimen of No. 329 at Paris is the same.

*Gloniopsis biformis* Sacc. Type not seen, but apparently Saccardo described specimens which he judged from external appearance to be the "biforme" of Fries. As Rehm suggests (6, p. 18), it is probably the same as *Gloniopsis curvata*.

*Hysterium (Hysterographium) Ceanothi* Phill. & Hark. Type material at the British Museum and at Kew ("2540 bis on *Ceanothus*, Harkness") has hysterothecia like those of *H. flexuosum* from Schweinitz, and spores  $44-58 \times 9-12 \mu$ , up to 15 septate and muriform, brown, with a gelatinous envelope around



the spore. The spores are slightly narrower than in the type of *Hysterographium flexuosum*, but it is undoubtedly that species.

*Hysterium chlorinum* Berk. & Curt. The type of this species at Kew is externally and microscopically like *H. Cyrillae*. The original description gives the spores as ".003 long": this is  $75\ \mu$ , but is given by Saccardo and by Ellis and Everhart as  $7.5\ \mu$ . Spores were found up to  $72\ \mu$ , with two unequal cells. The name is a synonym of *Glonium Cyrillae*.

?*Hysterium cinerascens* Schw. Represented at Kew by a fragment of wood  $17 \times 4$  mm. with about 30 hysterothecia. The wood is considerably decayed, light brownish except between the hysterothecia, where it is cinereous. Hysterothecia closely gregarious, linear, dull black,  $\frac{1}{2}$ - $2 \times \frac{1}{4}$  mm., groove closed or becoming open. A specimen under the microscope showed a few young, thick-walled asci, with spores very indefinite, and only a few are developed far enough to show a septum or two.

The specimen at Berlin, from Schweinitz from Link's herbarium, has a good number of hysterothecia, but the ones mounted were also immature and showed no spores.

Ellis and Everhart (2) found the specimens at Philadelphia to be in poor condition, although they report muriform spores, stated on p. 703 to be brown, and at the bottom of p. 675 to be hyaline. *H. cinerascens* must still remain in the doubtful group. As for Duby's description of Schweinitz' specimen (see 2, p. 675), it seems likely that the spores were "continuous" because immature, and that *Schizothyrium cinerascens* and *Henriquesia cinerascens* are meaningless names.

[*Hysterium confluens* Schw.] A specimen at Kew (No. 5689) is a thin splinter of wood  $12 \times 3 \times \frac{1}{2}$  mm. with about 75 blackish incrustations, some 7 of which show resemblance to hysterothecia (although rather too flat) and are  $\frac{1}{2}$ - $1 \times \frac{1}{3}$  mm. A more promising looking specimen was mounted, but revealed no sign of ascus or spore.

?*Gloniopsis connivens* (Cooke & Hark.) Pazschke. Specimens at Kew on *Ceanothus* from Harkness marked "*Hysterium connivens*" are somewhat immature, the asci  $110$ - $130 \times 14$ - $16\ \mu$ , 8 spored, uniseriate-overlapping; spores  $16$ - $21 \times 7$ - $10\ \mu$ , ends obtuse and rounded, hyaline, with 5-7 cross septa, and one or

two divisions have longitudinal septa. An illustration at Kew is marked "perhaps at length coloured." A specimen of Rabenhorst-Winter Fungi Europaei 3677 labelled "*Gloniopsis connivens* (Cooke & Harkn.) ad ramulos emortuos Ceanothi . . . San Francisco Calif. leg. Harkness" has spores  $18-24 \times 9-10 \mu$ , pale yellow, otherwise as above. *G. connivens* may be a distinct species, but its status is still uncertain.

*Gloniopsis curvata* (Fries) Sacc. Type not seen, but a number of European specimens considered to be this species have been examined, with spores  $16-22 \times 6-9 \mu$ , 4-7 septate and muriform, hyaline to pale yellow, often slightly constricted at the middle, rounded but often narrowed at the ends, surrounded by a gelatinous envelope which soon disappears in water. Specimens from *Rubus*, *Quercus*, *Alnus*, *Crataegus*, and other deciduous trees or shrubs appear indistinguishable.

*Hysterium Cyrillae* Berk. & Curt. The type (Curtis 2747) consists of three small twigs bearing a few scattered, erumpent-superficial hysterothecia,  $\frac{1}{2}-1 \times \frac{1}{4}-\frac{3}{4}$  mm., black, elliptical or oval, striate, cleft slightly open; asci  $180-225 \times 40-45 \mu$ , 8 spored, biseriate; spores  $54-82 \times 13-17 \mu$ , wall hyaline, spore contents pale greenish yellow, spore divided by a septum into two parts, one part nearly twice as long as the other, somewhat constricted at the septum. There is also at Kew a specimen of this species from Georgia.

Saccardo translated Berkeley's ".004 [inch] long" as  $10 \mu$ , as did Ellis and Everhart. It is really  $100 \mu$ , although no spore was seen which reached that length. The fungus has, however, striking spores. It is now called *Glonium Cyrillae* (Berk. & Curt.) Sacc.

?*Tryblidium dealbatum* Gerard. Type not examined, but a specimen at Kew labelled "ad corticem Syringae. Ex herb. W. R. Gerard" bears, on the whitened surface of the wood, several superficial apothecia (the cups are as in *Tryblidium*, and are too open for a *Hysterographium*). The spores are  $23-27 \times 12-14 \mu$ , pale yellow, 5-6 septate and muriform. Cooke made the combination *Tryblidium Syringae* (despite the fact that the spores of *Hysterium Syringae* Schw. are unknown), presumably because both are on the same host and there is a certain amount of

resemblance in the fruit bodies. Gerard's type specimens, and those examined by J. B. Ellis (2, p. 701) which were found to have spores "becoming dark brown and almost opaque," need to be studied, but it seems doubtful that the fungus is one of the Hysteriales.

*Lophium decipiens* Karst. (*Mytilidion decipiens* (Karst.) Sacc.). See *M. tortile*.

*Hysterium depressum* Berk. & Curt. The type at Kew is labelled in Berkeley's writing "3297 *Hysterium depressum* B. & C. Virginian mountains" and has a drawing by Berkeley of a young ascus and 4 spores. The specimen consists of two bits of wood bearing several hysterothecia which are superficial, gregarious, straight, boat shaped,  $\frac{1}{2}$ - $1\frac{1}{4} \times \frac{1}{3}$  mm., dull black, not definitely striate, nor is the "granulato-rugosum" of the original description a noticeable feature. The groove is closed or in some cases becomes opened slightly. The asci are immature, with the spore-bearing portion  $70-75 \times 19-24 \mu$ , 8 spored; the spores  $30-37 \times 6-7\frac{1}{2} \mu$ , 7-9 septate, with one cell usually enlarged, pale greenish yellow because of immaturity; paraphyses filiform. The original description gave the spores as ".0016 long" which Ellis and Everhart (2, p. 695) erroneously translate as  $30 \mu$ , but Saccardo compiled correctly as  $40 \mu$ . The writer's examination did not reveal a spore quite that long. It seems evident that the specimens represent somewhat young *Hysterium insidens*.

*Hysterium elongatum* Wahl. Type not seen, but a specimen at Paris marked No. 62 (from Fries?) has elongated hysterothecia and nearly opaque spores  $32-45 \times 10-14 \mu$ , 7-11 septate and muriform. Fuckel's Fungi Rhen. 1754 at Kew is similar. This fungus (*Hysterographium elongatum* (Wahl.) Corda) is recorded as rare in Europe. It has been reported from North America, first by Schweinitz, but his specimens at Kew and (see 2, p. 706) at Philadelphia are without spores. Berkeley (Grevillea 4: 10) lists for *H. elongatum* from Carolina the following specimens sent by Curtis: Nos. 171, 184, 270, 442, 714, 882, 904. These numbers are all at Kew, and were examined.

No. 171 has spores  $37-42 \times 7\frac{1}{2}-10 \mu$ , 6-11 septate, one cell large: evidently *Hysterium insidens*.

No. 184 has large spores  $63-72 \times 18-24 \mu$ , with 7 septa, 1 central and 3 near each end, as in *H. magnosporum* Gerard.

No. 270 has young spores about  $30 \times 10 \mu$ , and is possibly *Hysterographium subrugosum*.

No. 714 has 3-septate spores  $13-16 \times 5-6\frac{1}{2} \mu$ , and is doubtless *Hysterium angustatum*.

No. 882, with spores  $21-26 \times 7-9 \mu$ , 3-7 septate and muriform, is no doubt *Hysterographium Mori*.

Nos. 442 and 904 seemed to be without spores. Another American specimen at Kew, No. 43 from Peck, on *Quercus*, is labelled *H. elongatum*, but is *Hysterographium flexuosum*. It seems doubtful that *H. elongatum* really has been found in America.

*Hysterium Eucalypti* Phill. & Hark. Material at Kew marked "2405 on Eucalyptus, Harkness. Type" consists of 3 pieces of bark with hysterothecia erumpent, oval,  $\frac{1}{2}-\frac{3}{4} \times \frac{1}{4}$  mm., dull black, carbonaceous, not striate, groove noticeable. The asci are  $60-80 \times 11-12 \mu$  (spore bearing portion), 8 spored, biseriate; spores  $16-21 \times 5-6 \mu$ , 3 septate, all cells usually uniformly brown. As Ellis and Everhart report (2, p. 693), this is *H. angustatum*.

*Hysterium fibritectum* Schw. The specimen at Kew marked "Herb. Schwein. 2680" has beside it a drawing of three elliptical one-septate spores marked "colourless, 1-seriate." More than 100 hysterothecia occur on the piece of semi-rotted wood, and are small,  $0.3-0.4 \times 0.2-0.3$  mm., erumpent, dull black, with a depressed groove. A mount showed young asci, but a few of the spores were mature enough to escape. The spores were  $10-13 \times 3-4 \mu$ , hyaline, elliptical or fusoid, not constricted, with a median septum. The fungus at Kew is a *Glonium* resembling *G. nitidum* Ellis, and is on a substratum with bordered pits. Ellis and Everhart (2, p. 699) found the Philadelphia specimens "without fruit."

*Hysterium flexuosum* Schw. Co-type material at Kew bears several superficial hysterothecia  $1-2 \times \frac{1}{2}$  mm. The hysterothecia and spores are as in Schweinitz' specimen of *H. vulvatum* at Kew; the flexuous character of certain hysterothecia is an immaterial point in *H. flexuosum*. The fungus should be called *Hysterographium flexuosum* (Schw.) Rehm.

*Hysterium formosum* Cooke. The type (No. 1020) consists of

pine twigs bearing superficial, irregularly placed, elliptical hysterothecia,  $1-1\frac{1}{2} \times \frac{1}{2}$  mm., black, shining, striate, ends narrowed, groove closed; asci cylindrical,  $150-160 \times 12-14 \mu$ , 8 spored, uniseriate; spores  $18-24 \times 7-10 \mu$ , with 3 (sometimes 5) cross septa, one to three cells faintly longitudinally septate, slightly constricted in the middle, brown. No. 1028 on *Juniperus* is similar, except that the spores are slightly smaller; Ellis and Everhart, N. A. Fungi, 2d ser. 2062 is like the type but with some spores 6 septate. This fungus, *Hysterographium formosum* (Cooke) Sacc., is very near *H. Mori*. The description of *H. pumilionis* Rehm (6, p. 21) would fit *H. formosum* exceedingly well; it also is alpine.

*Hysterographium Fraxini* (Pers. ex Fries) de Not. Type not seen, but the name refers to a fungus widespread on ash, less common on other hosts.

*Hysterium fusiger* Berk. & Curt. The type at Kew from New England (Sprague No. 5830) is a piece of wood with five hysterothecia on the blackened surface. These are  $\frac{1}{2}-1 \times \frac{1}{3}-\frac{1}{2}$  mm., oval, black, somewhat striate, with the groove nearly closed. The asci are  $120-140 \times 13-18 \mu$ , ending in a short stalk, 8 spored, biseriate; paraphyses numerous, projecting above the asci, filiform; spores  $31-42 \times 7-9 \mu$ , brown, 6-9 septate, one cell sometimes larger. Berkeley remarked, "Resembling somewhat *H. tortile* and *graphicum* [i.e., *Mytilidion tortile* and *Glonium graphicum*] but with different sporidia." The hysterothecia are not conchiform like those of *Mytilidion*, and the species seems to be *Hysterium insidens*.

*Hysterium Gerardi* Cooke & Peck. The type from Peck marked "123 on old decorticated trunk of Chestnut *Castanea vesca* Poughkeepsie, N. Y. W. R. Gerard legit" bears several superficial, gregarious hysterothecia, ellipsoid or elongated, straight or curved, ends narrowed,  $\frac{1}{2}-1\frac{1}{4} \times \frac{1}{4}-\frac{1}{3}$  mm., dull black, groove closed. Spores  $16-20 \times 7-8 \mu$ , with 3 to 6 cross septa, and one or two cells with longitudinal septa. As Ellis and Everhart state (2, p. 703-4), it is *Hysterographium Mori*.

*Hysterium graphicum* Fries. Type not seen, but the name *Glonium graphicum* (Fries) Duby is used for a species which occurs in Europe on conifers. We have seen no American

specimens. Schweinitz' specimen at Kew so labelled, on *Sassafras*, seems to be *Hysterium pulicare*.

?*Hysterographium guaraniticum* Speg. Type not seen. B. Balansa in Pl. du Paraguay No. 3953 has distributed under this name specimens with crowded, superficial hysterothecia,  $\frac{3}{4}$ – $1\frac{3}{4}$   $\times$   $\frac{1}{2}$  mm., black, groove narrow; spores 16–21  $\times$  6–8  $\mu$ , 3–5 septate with one to three cells having longitudinal septa. This is doubtless *H. Mori*.

?*Hysterium hiascens* Berk. & Curt. The type was not found at Kew. Berkeley noted "disco aperto" and thought it allied to *Tryblidium rufulum*. Ellis and Everhart (2, p. 707) base their description on Rehm's Ascomycetes No. 314. This exsiccatum at Kew has spores somewhat larger (26–34  $\times$  10–13  $\mu$ ) than given in Ellis and Everhart, but is otherwise similar. The spores become dark brown, almost opaque. The status of the name, and of the species, is uncertain. (See 6, p. 21.) It would seem possible that No. 314, which has been called "*Hysterographium hiascens* Rehm," might be *H. subrugosum*. *Hysterium hiascens* Berk. & Curt. is a *Blitridium*, according to Rehm (l.c.).

?*Hysterium hyalinum* Cooke & Peck. The type at Kew is marked by Peck "47 *Hysterium Rousselii*? immature on wood of some deciduous tree Cold Spring, N. Y., June. Does not appear to be well developed, but I send it for what it is worth. C. H. P." After "immature" he has a drawing of a spore which looks like *Hysterographium Mori*. Three hysterothecia were examined, but all were immature and unsatisfactory; the spores are becoming brown, 20–23  $\times$  7–8, 3 septate. It does not look like *Hysterium pulicare*; it may indeed be young *Hysterographium Mori* as Peck intimates.

A specimen from Gerard, No. 124, in the *H. hyalinum* folder at Kew, is young *Hysterographium Mori*.

A specimen from Ellis in the same folder has hyaline immature spores.

*Glonium hyalosporum* Gerard. Type not seen, unless a specimen at Kew from Gerard is part of the type. This consists of a piece of gnarled wood with straight or flexuous hysterothecia bearing small spores mostly immature and pale, but some of them are mature enough to be brown and appear to be typical

*Hysterographium Mori*. Ellis and Everhart (2, p. 708) found the spores to become brown in a specimen of "*Hysterium hyalosporum* Ger."

*Hysterium insidens* Schw. The Schweinitz specimen at Kew consists of a small splinter of wood bearing a number of gregarious, superficial, small hysterothecia, oval to elliptical, straight or slightly curved, dull black, not striate, groove noticeable. The spores were found to be  $24-33 \times 7\frac{1}{2}-9 \mu$ , cinnamon brown, 5-8 septate, one cell often enlarged. This specimen at Kew agrees well with that of Schweinitz at Philadelphia, as described in Ellis and Everhart (2, p. 696). This species is a fairly common one, with hysterothecia and spores often somewhat larger than in the type.

A Schweinitz specimen at Berlin marked *II. insidens* consists of bits of wood bearing stromata resembling those of young *Hypoxylon* or *Diatrype*. It may have been the occurrence of this stroma on part of his specimen which led Schweinitz to remark "insidens crustae longe effusae nigrae." No hysterothecia were seen on the Berlin specimen.

Cooke (Grevillea 17: 58) mismeasured the spores of the Schweinitz specimen at Kew as " $45-50 \times 15 \mu$ ."

*Hysterographium (Gloniopsis) insigne* Cooke & Hark. Type material at Kew consists of gregarious oval to elongated hysterothecia,  $\frac{1}{2}-1 \times \frac{1}{4}-\frac{1}{3}$  mm., ends rounded, black, scarcely striate or shining, cleft somewhat open at maturity; spores  $17-22 \times 7-9 \mu$ , 5-7 septate and muriform, nearly hyaline, narrowed at the ends but not acuminate, slightly constricted at the middle. This fungus (*Gloniopsis insignis* (Cooke & Hark.) Berl. & Vogl.) is not conspicuously different from *G. curvata* as found in England.

[*Hysterium Kalmiae* Schw.] The Schweinitz specimen at Kew consists of two small pieces of a branch with several elongated black structures superficially resembling *Hysteria*, but no spores were found.

*Hysterographium kansense* Ellis & Ev. Type not seen, but Ellis & Ev., N. A. Fungi, 2d ser. 3037 "on bark of living *Quercus macrocarpa*, Rockport, Kansas, May 1893, E. Bartholomew" (the original collection was as above, but in Feb. 1893), has spores  $26-34 \times 9-12 \mu$ , and does not seem to be specifically distinct from *II. subrugosum*, which also occurs on oak.

*Hysterium Lesquereuxii* Duby. Specimens "ad ramos *Gleditsiae* prope Columbus (Ohio), Am. Bor." at Kew and the British Museum, and a similarly labelled specimen from Duby at Paris, which are all perhaps co-type material, consist of pieces of small branches bearing erumpent-superficial hysterothecia,  $1-1\frac{1}{2} \times \frac{1}{2}$  mm., scattered or crowded together, straight or curved, cleft noticeable. Asci about  $110 \times 15 \mu$ , 8 spored, biseriate; spores  $18-25 \times 7-10 \mu$ , brown, 3-7 septate with one to three of the cells having longitudinal septa; spores constricted at the middle. These specimens agree well with those from Louisiana described in Ellis & Everhart (2, p. 705). The fungus seems to be a well developed *Hysterographium Mori*.

[*Hysterium librincola* Schw.] The specimen at Kew from Schweinitz consists of a piece of stem  $50 \times 3$  mm. with a few elongated fruit bodies. The shape doubtless led Schweinitz to refer the fungus to *Hysterium*; but no groove is evident, and the fungus is one of the Imperfecti, with conidia  $4-6 \times 3-4 \mu$ , commonly with 4 cells remaining attached together. It is perhaps *Hormiscium hysterioides* (Corda) Sacc.

*Hysterium lineare* Fries. A specimen at Kew, No. 90 from Fries (Scl. Suec.), did not yield spores. The species is, however, considered common in Europe and America, and is now known as *Glonium lineare* (Fries) de Not.

*Hysterium Loniceræ* Phill. & Hark. Material at Kew marked "on *Lonicera*, Harkness 2472 Type" consists of two pieces of branches with many superficial, gregarious or scattered hysterothecia,  $\frac{1}{2}-1\frac{1}{2} \times \frac{1}{3}-\frac{1}{2}$  mm., linear to oval, dull black, cleft closed; asci  $100-125 \times 15-24 \mu$ , 8 spored, 1-2 seriate; spores  $22-29 \times 6-12 \mu$ , 5-7 septate and muriform, hyaline to pale yellow. The spores are rather immature, but the fungus cannot be very different from *Gloniopsis Verbasci*.

*Hysterium macrosporum* Peck. A bit of material "ex type, N. Greenbush, N. Y., on pine wood, C. H. Peck" was obtained through the kindness of Dr. House. The fungus is as described by Peck, and more fully by Ellis (2, p. 694), except that some of the hysterothecia exceed one millimeter in length. The spores are fusoid with rounded ends, clear chestnut brown, with the three septa about evenly spaced. A good species, differing



especially in the septation of the spores from *II. magnosporum* Gerard on deciduous wood. The spores are considerably larger than in *H. thujarum*.

*Hysterium magnosporum* Gerard. A specimen from Gerard at Kew has four hysterothecia which fit the description in Ellis and Everhart (2, p. 694). A drawing beside the packet shows a seven-septate spore, the two central cells somewhat larger. Data by W. Phillips at Kew give the spores as  $48-67 \times 15-20 \mu$ . The four hysterothecia were not disturbed by the writer, but the species appears to be a good one. Curtis evidently collected it in Carolina: see under *II. elongatum* above.

*Hysterium (Glonium) medium* Cooke. The type at Kew (No. 293 from Ravenel) bears superficial gregarious hysterothecia  $\frac{1}{3}-1\frac{1}{2} \times \frac{1}{4}-\frac{1}{2}$  mm., dull black, striate, groove closed; spores uniseriate or overlapping,  $6-8\frac{1}{2} \times 3 \mu$ , hyaline, 2-celled. The hysterothecia are in some cases larger than is usual in *Glonium parvulum*; there is no definite subiculum present, but that is a variable feature of *G. parvulum*; the two names are doubtless synonymous, as Lohman (4) has concluded.

*Hysterium Mori* Schw. Material from Schweinitz was not found at Kew, the British Museum, Berlin, or Paris. Ellis and Everhart report (2, p. 704) that satisfactory material was found in the Schweinitz herbarium. European herbaria contain a few specimens from North America, where the fungus is common. When found in Europe it is called *II. Rousselii*, for as Ellis and Everhart state, there seems to be no difference. Both belong to *Hysterographium*.

*Lophium mytilinum* Pers. ex Fries. A specimen of Fries Scler. Suec. 60 at Kew bears young long spores. While this particular specimen is not very satisfactory, the name applies to a definitely recognized fungus on coniferous bark and wood in Europe and North America.

?*Hysterographium naviculare* Karst. Specimens at Berlin, ex herb. Winter, on *Prunus Padus* from P. A. Karsten, were found to agree very well with the description (6, p. 20) of *II. Rehmianum* Sacc., except that the spores become nearly opaque.

*Lophium naviculare* Schw. The Schweinitz specimen at Kew consists of about 40 superficial non-conchiform hysterothecia

1-2½ × ½-¾ mm., with spores up to 64 × 17 μ, and muriform. It is *Hysteroglyphium flexuosum*.

*Glonium nitidum* Ellis. Material of this fungus was sent to Cooke, and published in Cooke and Ellis (*Grevillea* 8: 13), but the species was credited to Ellis alone. The type or co-type specimen at Kew is labelled "3016. *Glonium* on fir wood Newfield, J. B. Ellis." The host was determined for the writer at Kew to be *Cupressus* (*Chamaecyparis*), not fir. The hysterothecia are very small, ⅛-⅓ × ⅓-⅓ mm., somewhat erect, densely aggregated, superficial, oval, faintly striate, with a crest longitudinally along the top, the groove closed. Spores 6-8 × 2-2½ μ, 2-celled, not constricted at the septum, hyaline with a yellowish tinge. In the specimen of Ellis' *N. Am. Fungi* 270 at Kew the spores are slightly larger, 8-10 × 2½-3 μ, and also have a dilute brownish tinge. A specimen from Ellis at Berlin, collected Nov. 14, 1893, has still larger but similar spores up to 13 × 3 μ, and with a distinct brownish colour. This species is easily distinguished from *G. parvulum* by the non-constricted spores which become somewhat longer, and by the host. The dilute brown colour of the spores is not sufficiently marked to remove the species from *Glonium*.

*Hysterium nova-caesariense* Ellis. Type not seen. C. Roumeguère *Fungi Sel. Exs.* 4854 on pine bark from Ellis agrees with the description in Ellis and Everhart (2, p. 703), as does the Kew example of Rehm's *Ascom.* 313. The spores have no constriction. It appears to be a good species. Saccardo transferred it in error to *Mytilidion*; it is *Hysteroglyphium nova-caesariense* (Ellis) Roum.

[*Hysterium nucicola* Schw.] The parts of the original material at Kew and Berlin bear a number of small hysterioid bodies, but no spores were found.

?*Hysterium ovatum* Cooke. The type from Ravenel at Kew is very unsatisfactory: only a few immature hyaline triseptate spores 15-18 × 7-8 μ were found. Apparently a considerable collection of this was made by Ravenel, since his *Fungi Am.* 321 seems to be the same, but no asci or spores were found in this material at Kew. Cooke's sketch with the type shows non-septate nucleate spores. *H. ovatum* must be left in the doubtful group.

*Hysterium (Glonium) parvulum* Gerard. A specimen at Kew from Gerard on *Alnus*, Poughkeepsie, may be co-type material. This is evidently the fungus described by Gerard, and more fully by Ellis and Everhart (2, p. 682), and recently studied carefully by Lohman (4). A specimen from the Herb. State Botanist, Albany, N. Y., marked "probably co-type material" also has the hyaline 2-celled spores,  $7-8 \times 3 \mu$ , characteristic of *Glonium parvulum* (Ger.) Cooke.

*Hysterium praelongum* Schw. Co-type material at the British Museum and at Kew consists of bits of wood bearing several erumpent-superficial, gregarious hysterothecia, long ( $1\frac{1}{2}-4 \times \frac{1}{2}$  mm.; Schweinitz reported them up to 6 lines = 12 mm.), straight or flexuous, dull black and somewhat striate, cleft conspicuous. The spores appear somewhat immature, and are  $20-30 \times 8-12 \mu$ , 5-8 septate and muriform, hyaline, or pale yellow. Ellis and Everhart (2, p. 709) are correct in considering this to belong to *Gloniopsis Verbasici* (Schw.) Rehm, although "praelongum" is the earlier name.

*Hysterium prominens* Phill. & Hark. The type at the British Museum consists of several scattered, superficial hysterothecia,  $\frac{1}{2}-1\frac{1}{4} \times \frac{1}{3}-\frac{1}{2}$  mm., dull black, cleft becoming somewhat open. A specimen under the microscope showed only immature, rather small, muriform spores. Co-type material at Kew showed also the same young spores. The original description, however, gives the spores as  $40-50 \times 10 \mu$ , constricted at the centre, 7-11 septate, brown; Ellis N. Am. Fungi 2064 on the same host (*Salix lasiolepis*), also from California, sent by Harkness, has spores up to  $64 \times 14 \mu$ , 11-14 septate and muriform, constricted at the center, with a gelatinous envelope. No. 2064 is *Hysterographium flexuosum*. The original description also suggests *H. flexuosum*.

*Hysterium pulicare* Pers. ex Fries. Fries Scler. Suec. 61 at the British Museum has spores  $21-33 \times 7-9 \mu$ , 3 septate, center cells chestnut brown, end cells usually paler. American specimens commonly have smaller spores. Fries Scler. Suec. 91 "*Hysterium pulicare*  $\beta$  *betulinum* Kunze" has similar spores, but somewhat smaller. His Scler. Suec. 92, var. *lenticulare*, at the British Museum did not yield spores, but this variety from this

exsiccatum number is illustrated at Kew as having spores like the type. Varieties based on the shape and size of the hysterothecia are of little validity, except for the form *pedicellatum*, which is striking. Specimens of the varieties *laeve* and *angustatum* from Schweinitz are at Kew, but mature spores were not found. See *II. angustatum* and *II. acuminatum* above. *II. pulicare* is widespread on deciduous trees.

*Hysterium putaminum* Cooke. The type (No. 2603 from Aiken, S. Car.) consists of several broken pieces of peach stones. A half-stone placed in a separate packet bears on its inner surface several superficial, gregarious or scattered hysterothecia,  $\frac{1}{4}$ – $\frac{3}{4}$   $\times$   $\frac{1}{8}$ – $\frac{1}{4}$  mm., dull black, cleft nearly closed; asci 70–80  $\times$  15–18  $\mu$ , 8-spored, biseriate; spores 18–22  $\times$  7–8  $\mu$ , brown, 3–5 septate with one or two cells having longitudinal septa; spores somewhat constricted at the middle. It appears to be *Hystero-graphium Mori*, the hard substratum probably accounting for the small hysterothecia.

?*Glonium Ravenelii* Cooke & Phill. Type material sent to Cooke, marked in Ravenel's writing "3028 on bark of *Platanus occidentalis* March 1880, Seaboard of S. C., H. W. R.," is at Kew. Part of this collection was distributed later by Ravenel as his Fungi Am. 763, with the name *Glonium Ravenelii* Cooke & Phill. The specimens are as described in Ellis and Everhart (2, p. 684); a slight subiculum occurs only occasionally. The specimens examined were without definite spores. Part of the same collection, obtained from the Herb. State Botanist, N. Y., was carefully studied, but no well formed spores were found.

*Hysterium repandum* Bloxam. The type at the British Museum, and some twenty small packets of this distinctive fungus at Kew, have been examined. All are apparently from Bloxam's collection on rotten stumps, Orton Wood, near Twycross, Leicestershire, England. Reported also from Belgium. No specimens were seen at Paris. The fungus is now called *Farlowiella repanda* (Blox.) Sacc.

[*Hysterium Rhois* Schw.] Co-type material at Berlin shows no true *Hysterium*, but only a few vague blackish bodies, perhaps stromatic in nature.

*Hysterium Rousselii* de Not. Type not seen, but specimens

in European herbaria appear identical with *Hysteroglyphium Mori*.

[*Hysterium rugulosum* Schw.] Co-type material at Kew consists of a piece of wood  $19 \times 4 \times 4$  mm. with about 25 hysterothecia  $\frac{1}{2}$ – $1 \times \frac{1}{4}$  mm., massed together, oval, groove closed. No spores were found. Berkeley has a note beside the specimen, "no spores seen."

[*Hysterium Sambuci* Fries.] A specimen from Schweinitz at Kew bears a few obscure black structures, but nothing resembling a *Hysterium*, nor were spores found.

*Lophium Sassafra* Schw. The Schweinitz specimen at Kew bears about a dozen superficial, rather erect hysterothecia,  $1\text{--}2 \times \frac{1}{2}\text{--}\frac{3}{4}$  mm., black, striate, groove closed; asci about  $280 \times 30 \mu$  with 4 overlapping spores which are  $81\text{--}107 \times 23\text{--}30 \mu$ , becoming opaque cinnamon brown and up to 18 or 20 septate, the end cells often lighter in colour. This is *Ostreion americanum* as represented at Kew.

*Glonium simulans* Gerard. A specimen at Kew labelled "North American Fungi No. 136, W. R. Gerard, Poughkeepsie, N. Y." bears gregarious or scattered superficial hysterothecia,  $\frac{3}{4}\text{--}1\frac{1}{2} \times \frac{1}{3}$  mm., striate, linear with obtuse ends; spores  $11\text{--}16 \times 4 \mu$ , hyaline, 2-celled, slightly constricted. This appears to be a distinct species.

*Glonium stellatum* Muehlenb. A specimen from Schweinitz at Kew is as described in Ellis and Everhart (2, p. 680) and elsewhere. The spores were found to be  $20\text{--}28 \times 4\text{--}6 \mu$ . It is a common species in North America.

?*Hysterium* (*Hysteroglyphium*) *stygium* Cooke. Type material at Kew from Ravenel (Nos. 3046, 3047, 3048) consists of whitened lichen-covered wood bearing fruit bodies becoming cupulate,  $\frac{1}{2}\text{--}1 \times \frac{1}{2}$  mm.; spores not in good condition, but some were found  $30\text{--}40 \times 14\text{--}20 \mu$ , yellowish, muriform. Ellis and Everhart (*Erythea* II, p. 23) report that authentic material was "almost pezizoid" with asci  $75\text{--}80 \times 22\text{--}25 \mu$  and spores  $25\text{--}30 \times 12\text{--}14 \mu$ . The fungus is not a good member of the Hysteriales: possibly *Blitridium hiascens* (Berk. & Curt.) Sacc. A specimen at Berlin from Missouri (Demetrio) marked *H. stygium* failed to yield good spores.

*Hysterium subrugosum* Cooke & Ellis. Type material at Kew is as recorded in Ellis and Everhart (2, p. 702), except that the asci and spores were found to be somewhat longer (asci 85–90  $\times$  18–27  $\mu$ , with a short stipe about 15  $\mu$  long; spores 27–33  $\times$  10–12  $\mu$ , not constricted, chestnut-brown). Ellis' N. A. Fungi 459 at Kew was found to agree. Illustrated by Cooke (*Grevillea* 5: pl. 81, fig. 1) but the spores are given by him in error as 45  $\times$  15  $\mu$ . This fungus, *Hysterographium subrugosum* (Cooke & Ellis) Sacc., differs from *H. Mori* in possessing larger, non-constricted spores.

*Hysterium (Gloniella) syncophilum* Cooke. The type from Ravenel at Kew is marked in Masee's writing "a lichen! *Opegrapha varia*." Ellis and Everhart also found specimens from Ravenel to be *Opegrapha*.

[*Hysterium Syringae* Schw.] Co-type material at Kew consists of 3 pieces of old wood, each bearing a number of superficial hysterothecia, gregarious or scattered, oval to oblong, ends rather abruptly rounded,  $\frac{1}{2}$ –1  $\times$   $\frac{1}{4}$ – $\frac{1}{2}$  mm., black, groove not opened. No spores were found, and Ellis and Everhart (2, p. 702) report none for material in the Schweinitz herbarium. See *Tryblidium dealbatum* above.

*Hysterium thujarum* Cooke & Peck. The specimen at Kew, probably the type, is labelled only "*H. thuiarum* C." and consists of a piece of bark bearing a number of superficial, scattered or gregarious hysterothecia,  $\frac{1}{2}$ –1 $\frac{1}{2}$   $\times$   $\frac{1}{3}$ – $\frac{1}{2}$  mm., oval to linear, rounded or pointed at the ends, dull black, not or faintly striate, cleft not conspicuous and nearly closed; asci 150–160  $\times$  16–19  $\mu$ , with a curved stalk about 50  $\mu$  long, with 8 or fewer spores, uniseriate and overlapping; spores mostly 30–34  $\times$  12–13  $\mu$ , but ranging from 26–40  $\times$  10 $\frac{1}{2}$ –15  $\mu$ , nearly always 3 septate, sometimes 4 or 5 septate, fusoid, becoming dark chestnut brown throughout.

On the same sheet at Kew is a specimen "on bark of *Thuja occidentalis*, New Baltimore, June, Dr. E. C. Howe legit" which bears the same fungus. A specimen on the same host from Manlius, N. Y., C. H. Peck, from Herb. N. Y. State Botanist, has also been examined, but is without spores.

*Hysterium thujarum* differs from *H. macrosporum* Peck in possessing smaller spores.

*Hysterium tortile* Schw. A specimen from Schweinitz at Kew bears several erect, gregarious, superficial hysterothecia  $1-1\frac{1}{2} \times \frac{1}{2}$  mm., elliptical, faintly striate, black, groove closed. The asci are about  $100 \times 6 \mu$  (spore bearing portion), cylindrical; spores uniseriate or somewhat overlapping,  $13-16 \times 4-5 \mu$ , brown, 3 septate, mostly not constricted at the septa. The specimen examined was in excellent condition. The fungus is now called *Mytilidion tortile* (Schw.) Sacc. European specimens labelled "*M. tortile*" were, so far as seen, another fungus with much larger spores. *M. decipiens* (Karst.) Sacc., as represented by Karsten's Fungi Fennici 767 at Berlin, also has 3-septate brown spores  $12-16 \times 4-5 \mu$ , although the hysterothecia are smaller than those of the type of *M. tortile*.

*Hysterium truncatulum* Cooke & Peck. The type specimen at Kew (Peck 165) consists of a bit of old wood bearing a number of oval to elliptic superficial hysterothecia,  $\frac{1}{2}-1 \times \frac{1}{3}-\frac{1}{2}$  mm., striate, dull black, groove narrow. Asci were found to be  $100-110 \mu$  long (spore bearing portion), biseriate, spores  $27-30 \times 6\frac{1}{2}-9 \mu$ , 3 septate, chestnut brown with terminal cells lighter in colour. Phillips' notes at the British Museum give the spores as  $25-30 \times 5-10 \mu$ , to which he added "*= H. pulicare*" and Cooke has added a memorandum "Yes M. C. C." Cooke's original description gave the spores as  $35-40 \times 10 \mu$ , but this is too large. The fungus is typical *H. pulicare*; in many American and some European collections the spores are somewhat shorter.

*Hysterium variabile* Cooke & Peck. The type at Kew marked by Peck "21 on old chestnut posts, Albany, May" bears many superficial hysterothecia,  $1-2 \times \frac{1}{2}$  mm., dull black, cleft noticeable but nearly or entirely closed; spores  $16-22 \times 7\frac{1}{2}-9 \mu$ , with 4-6 cross septa and 2 or 3 cells having longitudinal septa, chestnut brown. Asci about  $100 \times 10 \mu$ , short-stipitate, 8 spored, uniseriate or overlapping; paraphyses filiform. Another specimen at Kew "37 . . . on dead decorticated branches of some deciduous tree, Albany, May, C. H. P." is marked by Cooke "*variabile* C. & P.?" It is doubtful if this is not distinct from No. 21." No. 37 has spores  $17-21 \times 7\frac{1}{2}-9 \mu$ , as in No. 21. Both are *Hysterographium Mori*. Specimens collected by Peck and labelled *H. variabile*, obtained from the Herb. State Botanist, N. Y., were also found to be *H. Mori*.

*Hysterium varium* Fries. Type not seen; according to Rehm (6, p. 235) this fungus is a *Trybliella*. Schweinitz recorded it from Pennsylvania, but his specimen at Kew could not be determined. A specimen from Curtis, considered by Berkeley to be *Hysslerium varium*, seems to be *Ostreion americanum*.

*Hysterium Verbasci* Schw. Co-type material at Kew has a half dozen linear hysterothecia,  $1-1\frac{1}{2} \times \frac{1}{5}-\frac{1}{3}$  mm., and several more immature ones. The asci and spores are immature even in the larger hysterothecium examined, and the septa were scarcely visible. Duby's description of Schweinitz' specimen was based upon similar immature material, and from Duby's report that the spores were continuous Saccardo transferred the species to *Schizothyrium*. Rehm (*Hedwigia* 25: 147) found septa in Duby's material from Schweinitz, and reported it as *Gloniopsis*. The Schweinitz specimen at Berlin has, moreover, spores mature enough to escape readily from the asci; these are  $22-26 \times 8-10 \mu$ , hyaline with a slight tinge of yellow, 7-8 septate and fenestrate. The fungus is a *Gloniopsis* (*G. Verbasci* (Schw.) Rehm). *G. decipiens* de Not. does not seem to be very different, but authentic specimens have not been examined.

*Hysterium viticola* Cooke & Peck. The type (Peck 124) at Kew consists of two specimens. The first is labelled in Peck's handwriting "*Hysslerium* 124 on dead grape vine, Vitis, Poughkeepsie, N. Y., W. R. Gerard legit" to which Cooke had added "*viticolum*" after "*Hysslerium*." No spores were found. The second specimen (which is doubtless really the type, since it has spores) is marked, also in Peck's writing, "124 resent. *Hysslerium* on dead grape vine Greenbush, N. Y., Oct. This is like Gerard's I suppose, which I sent as No. 124. He sends very small bits . . . C. H. P." To this Cooke had also added "*viticolum*." In both specimens the hysterothecia are superficial,  $\frac{1}{2}-1\frac{1}{2} \times \frac{1}{3}$  mm., black; in the second the spores are  $16-21 \times 7-8 \mu$ , 3-5 septate with a couple of cells having longitudinal septa. Ellis and Everhart (2, p. 703-4) are correct in referring the species to *Hysterographium Mori*. A specimen "*Hysslerium* on *Rubus* Ellis 2299, New Jersey" also marked by Cooke "*viticolum*" (and which probably represents the "var. *ruborum* Cooke" of Rehm's *Ascomycetes* 364) is also *II. Mori*. Several specimens collected by Ellis are filed under *II. viticolum* at Berlin.



*Hysterium vix-visibile* Gerard. Type not examined, but specimens from Gerard at Kew have pale brown spores  $12-15 \times 4\frac{1}{2}-5 \mu$ , and small apothecia characteristic of *Hysteropatella Prostii*, as Shear noted (see his N. Y. Fungi 183). Specimens from Sandlake, N. Y. (C. H. Peck), from the Herb. State Botanist, N. Y., also agree with *H. Prostii*.

*Hysterium vulvatum* Schw. A specimen at Kew from Schweinitz bears 5 hysterothecia  $1-1\frac{1}{2} \times \frac{1}{2}$  mm., straight, cleft conspicuous; asci  $120-150 \times 30-40 \mu$ ; spores brown,  $39-56 \times 12-16 \mu$ , 9-13 septate and muriform, constricted at the middle, with a gelatinous envelope around the spore. It is a *Hysterographium* (*H. vulvatum* (Schw.) Sacc. = *H. flexuosum* (Schw.) Sacc.), and is common in North America. *H. Rehmi-anum* is a somewhat similar species in Europe, but it apparently has smaller spores.

#### SUMMARY

This paper deals with some of the names that have been applied to certain lignicolous and corticolous Hysteriales. The eleven genera mentioned below were considered by Höhnelt (3) to constitute the Hysteriales, but the common, and doubtless more correct, practise is to include several other genera in the group. Keys are provided by Rehm (6), by Ellis and Everhart (2), and by Clements and Shear in their recent "Genera of Fungi."

The characters of the hysterothecia are of diagnostic value, particularly in separating genera, but the spores provide the main differentiating features. The host or substratum should be identified in collecting the Hysteriales; one usually will find that species occurring upon conifers differ from those on deciduous plants, although a few species develop upon both types of substratum. Some confusion has resulted from the interpretation of immature spores temporarily hyaline as belonging to genera with spores permanently hyaline.

In the brief summaries given here of certain species, and based primarily upon examinations of type specimens, it must be remembered that few of the described species are included, and the distinguishing characters mentioned below are principally size of spores, type of host, and distribution. It is hoped, how-

ever, that the data presented in this paper may aid mycologists in determining some of the commoner Hysteriales.

1. *Bulliardia* Sacc. was separated from *Mytilidion* because the spores are only two celled. Fungi belonging to this genus have not been examined by the writer.

2. *Dichaena* Fries, is not included in this article. Species of *Dichaena* are often easily recognized from their macroscopic appearance, but the microscopic characters are usually uncertain.

3. *Farlowiella* Sacc. consists of *F. repanda* (Blox.) Sacc. as the only well known species.

4. *Gloniella* Sacc. includes fungi with spores having three or more cells which remain hyaline; some species occur on herbaceous plants. No good species of *Gloniella* is discussed in this paper. *G. ovata* (Cooke) Sacc. is unsatisfactory; nor is it a good basis for Rehm's genus *Hysteroglonium*.

5. *Gloniopsis* de Notaris, corresponds to *Hysterographium*, except that the spores remain hyaline. None of the species mentioned herein were found upon conifers. *G. curvata* (Fries) Sacc. occurs in Europe and probably in North America, and has spores  $16-22 \times 6-9 \mu$ . *G. biformis* Sacc. and *G. insignis* (Cooke & Hark.) Berl. & Vogl. may be synonymous names.

*G. Verbasci* (Schw.) Rehm, is found in North America and perhaps in Europe, with spores  $20-30 \times 8-12 \mu$ , and *Hysterium praelongum* Schw. and *H. Lonicerae* Phill. & Hark. appear to be synonymous. *G. decipiens* de Notaris must be very similar.

*G. connivens* (Cooke & Hark.) Pazschke, from North America has spores  $16-24 \times 8-10 \mu$  and may be distinct from *G. curvata* in somewhat wider, more obtuse spores.

6. *Glonium* Muehlenberg, is based on *G. stellatum* which occurs in North America on coniferous (and other?) substrata, and has spores  $20-28 \times 4-6 \mu$ . *G. accumulatum* Schw. is synonymous. *Glonium* as delimited by von Höhnelt includes only species with a definite subiculum; it has even been suggested by others that *G. stellatum* does not belong to the Hysteriales. *G. graphicum* (Fries) Duby has a less dense subiculum which may even be lacking; it occurs on conifers in Europe, and has spores  $21-27 \times 5-7 \mu$ . For species of *Glonium* without subiculum von Höhnelt proposed the sub-genus *Psiloglonium*, which Petrak (Ann.

Myc. 21: 227) raised to generic rank. We have left the species below in *Glonium*.

*G. parvulum* (Gerard) Cooke, occurs in North America (and Europe?) on deciduous woody plants, and has small spores  $6-8 \times 2-3 \mu$ . *Hysterium abbreviatum* Schw. and evidently *H. medium* Cooke, are synonymous.

*G. nitidum* Ellis, occurs on conifers in North America, and has non-constricted spores  $6-13 \times 2-3 \mu$ . *Hysterium fibritectum* Schw. at Kew appears to be the same.

*G. simulans* Gerard, occurs in North America, and has spores  $10-16 \times 4-5 \mu$ , slightly constricted.

*G. lineare* (Fries) de Not. occurs on deciduous woody plants in Europe and North America. It has spores  $10-15 \times 6-8 \mu$ .

*G. Cyrillae* (Berk. & Curt.) Sacc. with which *Hysterium chlorinum* Berk. & Curt. is synonymous, is found on deciduous plants in North America. It has large spores,  $54-82 \times 13-17 \mu$ .

7. *Hysterium* Tode ex Fries, has brown spores with cross septa. *H. pulicare* Pers. ex Fries occurs on deciduous woody plants in Europe, America, and elsewhere, and has spores  $18-33 \times 7-9 \mu$ , 3 septate with end cells paler. *H. acerinum* West., *H. betulignum* Schw., and *H. truncatulum* Cooke & Peck are some of the synonyms; the *H. biforme* of Fries' Scler. Suec. seems to be the same.

*H. acuminatum* Fries, is the name applied to an alpine form on conifers in Europe with spores  $13-16 \times 5-6 \mu$ .

*H. angustatum* Alb. & Schw. occurs on deciduous woody plants in Europe and America, with spores  $15-22 \times 5-7 \mu$ , uniformly brown. *H. Eucalypti* Phill. & Hark. is the same.

*H. insidens* Schw. is found in North America, and probably in Europe, on deciduous (and coniferous?) plants, and has spores  $24-40 \times 6-10 \mu$ , with one cell commonly larger than the others. *H. depressum* Berk. & Curt., *H. fusiger* Berk. & Curt., and perhaps *H. Berengerii* Sacc. are considered synonymous. Intergrading forms seem to invalidate any effort to distinguish two species here, based on length of spores.

*H. thujarum* Cooke & Peck, develops on conifers in North America, and has spores  $30-40 \times 10-14 \mu$ .

*H. macrosporum* Peck, also occurs on conifers in North America, and has spores  $40-57 \times 11-15 \mu$ .

*H. magnosporum* Gerard, has been collected on deciduous woody plants in North America, and has spores  $50-65 \times 15-20 \mu$ .

8. *Hysterographium* Corda, has muriform brown spores. All the names in Ellis and Everhart (2), Rehm (6), and Masee (5), and one or two other names, are considered in this paper. The writer believes that these should be accounted for under the following eight names:

*H. Mori* (Schw.) Rehm, is a common species on deciduous and coniferous wood or bark in America and Europe, with spores  $15-25 \times 7-9 \mu$ . The following appear to be the same: *Hysterium acuminatum* of Herb. Schw., *H. Gerardi* Cooke & Peck, *H. guaraniticum* of Balansa's Plants, *H. Lesquereuxii* Duby, *H. putaminum* Cooke, *H. Rousselii* de Not., *H. variabile* Cooke & Peck, *H. viticola* Cooke & Peck, and *Glonium hyalosporum* Gerard.

*H. formosum* (Cooke) Sacc. on alpine conifers in North America and probably in Europe, has spores  $18-24 \times 7-10 \mu$ . *H. Pumilionis* Rehm is apparently the same. *H. formosum* is very close to, or possibly identical with, *H. Mori*, but may be distinct in possessing longer asci and somewhat smaller hysterothecia.

*H. subrugosum* (Cooke & Ellis) Sacc. occurs on *Quercus* in North America. The spores are  $25-40 \times 10-12 \mu$ . *H. hiaseus* Rehm and *H. kansense* Ellis & Ev. may be synonymous.

*H. Rehmianum* Sacc. is found in Europe on deciduous trees, with spores  $30-40 \times 12-14 \mu$ . *H. naviculare* Karst. is possibly identical.

*H. Fraxini* (Pers. ex Fries) de Not. on ash, etc., is widespread. The spores are  $30-40 \times 15-20 \mu$ .

*H. elongatum* (Wahlenb.) Corda, is rare on *Salix* in Europe. The spores measure  $30-45 \times 10-15 \mu$ .

*H. nova-caesariense* (Ellis) Roum. on *Pinus* in North America has spores  $35-50 \times 10-13 \mu$ .

*H. flexuosum* (Schw.) Rehm, on deciduous woody plants in North America has the largest spores,  $39-62 \times 12-20 \mu$ . *Hysterium Ceanothi* Phill. & Hark., *H. prominens* Phill. & Hark., *H. vulvatum* Schw., and *Lophium naviculare* of Herb. Schw. at Kew appear to be synonymous.

9. *Lophium*, with filiform spores and erect hysterothecia, is based on *L. mytilinum* (Pers.) Fries, which occurs on conifers in America and Europe; the spores are  $120-150 \times 1\frac{1}{2}-2 \mu$ .

10. *Mytilidion* (*Mytilidium*) Duby, has upright hysterothecia and spores three or more celled. *M. tortile* (Schw.) Sacc. occurs on *Juniperus* in North America, with spores  $12-16 \times 4-5 \mu$ . *M. decipiens* (Karst.) Sacc. is a similar or possibly identical species in Europe, but *M. tortile* as described by Rehm (6, p. 23) is another fungus with larger spores.

11. *Ostreion* (*Ostreium*) Duby, is based on *O. americanum*, which occurs in North America on *Liquidambar* and *Sassafras*, with spores  $80-120 \times 25-35 \mu$ . *Lophium Sassafras* Schw. was found to be this species. *O. europaeum* Duby was found by Rehm (see 6, p. 14) to be *Hysterium pulicare* form *pedicellatum*. *Ostreion* appears to differ from *Mytilidion* principally in the size of the spores, and the two names should probably be merged, as is done by Clements and Shear.

The following species were found by the writer, and in most cases by others previously, to be undeterminable, or to belong to other organisms than the Hysteriales: *Hysterium Azaleae* Schw., *H. confluens* Schw., *H. Kalmiae* Schw., *H. librincola* Schw., *H. nucicola* Schw., *H. rhois* Schw., *H. rugulosum* Schw., *H. Sambuci* of Herb. Schw., *H. stygium* Cooke, *H. Syringae* Schw., *H. synophilum* Cooke, *H. varium* Fries, and *H. vix-visibile* Gerard.

These names are still doubtful: *Tryblidium dealbatum* Gerard, *Hysterium cinerascens* Schw., *H. hiascens* Berk. & Curt., *H. hyalinum* Cooke & Peck, *H. ovatum* Cooke, and *Glonium Ravenelii* Cooke & Phil.

The writer is glad to acknowledge the kindness of the authorities in the Herbaria visited, and particularly that of the following mycologists: Miss E. M. Wakefield of Kew, Mr. J. Ramsbottom of the British Museum (Natural History), M. Roger Heim at Paris, Dr. Ulbrich of Berlin, Dr. E. J. Butler of the Imperial Mycological Institute, Kew, and Dr. H. D. House, State Botanist, Albany, New York. The writer would be glad to receive specimens or information from anyone interested in the Hysteriales.

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## SOME SPECIES OF *PLASMOPARA* ON COMPOSITES FROM GUATEMALA

LEO CAMPBELL

(WITH 1 TEXT FIGURE)

In recent investigations of *Plasmopara* on composites from Guatemala and Illinois, the writer has observed a wide variation in the morphology in apparently the same species of *Plasmopara*. On different hosts, however, clearly discernible variations were found which appear to be sufficiently constant to warrant the separation of these fungi as distinct species.

Cross inoculation experiments will be undertaken with those of which fresh material is available. Only those from Guatemala, of which fresh material is not available for inoculation, will be considered here.

Up to the present time all specimens of *Plasmopara* reported on the Compositae have been called *Plasmopara Halstedii* (Farl.) Berl. & De Toni, with the exception of *Plasmopara Vernoniae-chinensis* Saw. established by Sawada on *Vernonia chinensis* Less. in Formosa in 1919 (4). Ellis preferred to call *Plasmopara* on *Ambrosia artemisiifolia* L., *P. Halstedii* var. *Ambrosiae* (1), and Toro, who reported a *Plasmopara* on *Bidens cynapiifolia* H. B. K., states it shows great variation from *P. Halstedii* “. . . especially with respect to the swelling of the branches. It is also unlike the other specimens on other hosts, in that the epispore is smooth instead of wrinkled” (5). Referring to *P. Halstedii*, Farlow states, “. . . we may expect to find it on almost any composite, although it apparently affects principally the Tubuliflorae” (3).

As yet *P. Halstedii* has been reported only on the Tubuliflorae, which is now commonly divided into two families, the Ambrosiaceae and the Corduaceae. Considering the large number of variable species of these two families, it may be expected that the *Plasmopara* parasitic on them might vary sufficiently from *P. Halstedii*, as originally described, to be separated from it as distinct species. Wilson (6) and others have expressed their

opinions that the species should perhaps be divided into several. This was the belief of Prof. Palm, who suggested this study.

The material from Guatemala was collected by Prof. Palm. *Plasmopara* were examined from some twenty specimens of composites of which only the following were specifically determined:

*Gnaphalium purpureum* L., San Rafael (6000 feet above sea level) near Guatemala City.

*Bidens pilosa* L., Guatemala City.

*Erigeron scaposus* D. C., San Rafael.

*Spilanthes ocimifolia* (Lam.) Moore, San Rafael.

*Zinnia multiflora* L., Amatitlan Lake.

*Eupatorium areolare* D. C., Antigua.

*Galinsoga parviflora* Cav., Guatemala City, San Rafael, and Antigua.

On all but *E. areolare* and *G. parviflora*, the specimens of *Plas-*

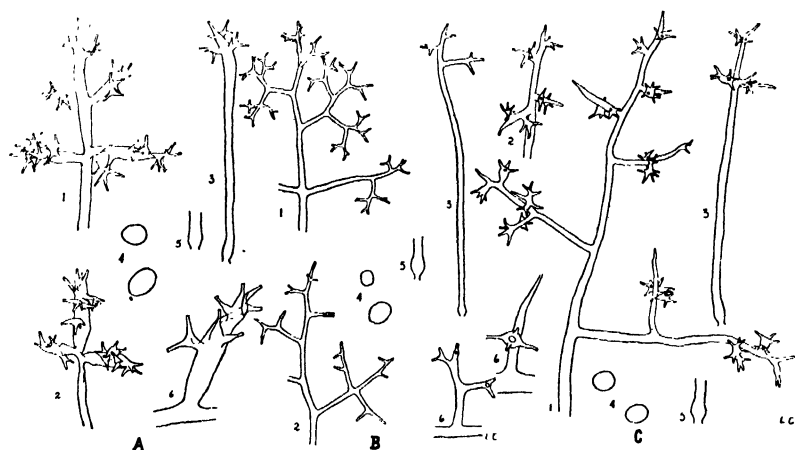


FIG. 1. A: *P. Palmii*; 1-2, Branching axes of conidiophores showing general characters; 3, Small conidiophore commonly found; 4, Two typical conidia; 5, Base of conidiophore showing slight enlargement; 6, Short branch of conidiophore enlarged to show detail. B: *P. Galinsogae*; 1-2, Branching axes of conidiophores showing general characters; 3, Small conidiophore commonly found; 4, Two typical conidia; 5, Base of conidiophore showing distinct enlargement; 6, Short branch of conidiophore enlarged to show detail. C: *P. Halstedii*; 1, Upper portion, and 2, entire branching axes of conidiophores, showing general characters; 3, Small conidiophore commonly found; 4, Two typical conidia; 5, Base of conidiophore showing distinct enlargement; 6, Short branch of conidiophore enlarged to show detail.



*mopara* were identified as *P. Halstedii*. Of the others, *E. scaposus*, *S. ocimifolia* and *Z. multiflora* have not previously been reported as hosts of *P. Halstedii*. They are here reported as additions to the host list of the pathogen; *S. ocimifolia* and *Z. multiflora* representing two new genera.

The *Plasmopara* on *E. areolare* caused distinct light-brown discolored spots on the leaves, but the fungus was somewhat inconspicuous due to the scanty production of conidiophores. It differed from *P. Halstedii* principally in the character of the conidiophores, the main axes of which tend to increase in diameter from the base to near the tip. The base of the conidiophores is relatively small and usually without the bulbous enlargement so common in *P. Halstedii*, and the branching axes are distinctly swollen; a character which readily distinguishes it from *P. Halstedii*. The dimensions of the conidia are greater, and the sterigmata are shorter and stouter than the sterigmata of *P. Halstedii* which often reaches a length of 36  $\mu$ .

The *Plasmopara* found on *G. parviflora*, in three different localities in Guatemala, produced light-brown discolored spots on the leaves where the fungus, due to the rather abundant production of conidiophores, was very evident. This fungus is readily distinguished from *P. Halstedii* by the tall, slender conidiophores. As in *P. Halstedii*, there is usually a distinct enlargement at the base, but, as with the other corresponding parts of the conidiophores, the diameter is much less than in *P. Halstedii*. The conidia are smaller, and the long sterigmata so common in *P. Halstedii*, are not to be found in this fungus.

The writer is of the opinion that the two new forms of *Plasmopara*, discussed above and characterized below, differ sufficiently from *P. Halstedii*, as originally described, to be of specific rank, and chooses to call the fungus on *E. areolare*, *Plasmopara Palmii*, and the one on *G. parviflora*, *Plasmopara Galinsogae*.

Specimens of each are deposited in the herbarium of the university of Illinois.

***Plasmopara Palmii* Campbell, sp. nov. on *Eupatorium areolare* D. C.**

Hypophyllous, causing small light-brown discolored spots

covered with a scanty production of conidiophores; conidiophores robust, 2–6 times branched, 250–900  $\mu$  high; base usually without distinct enlargement, 8.5–17  $\mu$  broad; diameter immediately before first branch 9–17  $\mu$ ; branching axes usually broader and characteristically swollen; first branch 2–5 times branched, 25–250  $\mu$  long, often swollen and club-shaped; conidia oval or elliptic,  $12.5 \times 24\text{--}24 \times 40 \mu$ ; sterigmata stout, 3.5–17  $\mu$  long. No oöspores were found.

Hyphis hypophyllis, maculos subnigros facientibus; hyphis conidiophoris robustis, 2–6-ies ramosis, 250–900  $\mu$  altis, basi 8.5–17  $\mu$  latis, ante ramum primum 9–17  $\mu$ ; ramo primo 25–250  $\mu$  longo; conidiis ovoideis ellipsoideis,  $12.5 \times 24\text{--}24 \times 40 \mu$ ; sterigmatibus robustis; 3.5–17  $\mu$  longis; oösporis non visis.

**Plasmopara Galinsogae** Campbell, sp. nov. on *Galinsoga parviflora* Cav.

Hypophyllous, causing small light-brown discolored spots covered with conidiophores, usually appearing as white cottony mats; conidiophores slender, 3–8 times branched, 400–1000  $\mu$  high; base 5.5–12  $\mu$  broad; diameter immediately before first branch 5.5–10  $\mu$ ; first branch 3–5 times branched, 150–400  $\mu$  long; conidia oval or elliptic,  $8 \times 8.5\text{--}17 \times 20 \mu$ ; sterigmata slender, 3.5–17  $\mu$  long. No oöspores were found.

Hyphis hypophyllis, maculos subnigros facientibus; hyphis conidiophoris gracilibus 3–8-ies ramosis, 400–1000  $\mu$  altis, basi 5.5–12  $\mu$  latis, ante ramum primum 5.5–10  $\mu$ ; ramo primo 150–400  $\mu$  longo; conidiis ovoideis ellipsoideis,  $8 \times 8.5\text{--}17 \times 20 \mu$ ; sterigmatibus gracilibus, 3.5–17  $\mu$  longis; oösporis non visis.

The writer wishes to express his indebtedness to Prof. Bjorn Palm for having furnished the material, and for his efficient guidance in the completion of this work.

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# NOTES ON BOLETES. I

WALTER H. SNELL

(WITH 1 TEXT FIGURE)

## 1. BOLETUS PORPHYROSPORUS

During the past two summers in the Adirondacks in New York, where the writer has been making persistent searches for boletes, a single plant was quite often found in one locality, which could not be identified with the help of American literature on the subject. This plant was noteworthy in three respects:— (1) the pileus and stipe were light olive brown to dark brown, turning black with age; (2) the spore print was a light reddish purple, quite different from the color of any described American species; (3) when spore prints were made on white paper, the paper was stained a bluish green. A search through European literature showed that it was a familiar Friesian species, *Boletus porphyrosporus* (FIG. 1). Thus far the writer has been able to find no mention of this species in America. There are no specimens of this species in the Farlow Herbarium at Harvard, but there is one at the New York Botanical Garden, which was sent by Bresadola.

The specimens obtained came from a single hollow in the Pack Forest operated by the New York College of Forestry near Warrensburg, N. Y. Continued collecting through the Adirondacks in similar forest stands has thus far revealed no other specimens. It would appear that this species is not generally distributed on this continent or even in this section of the country, and the material may possibly have been introduced with forest tree seed or seedlings which have been planted in the Forest. It so happens that only three plants were found in 1930 and several more in 1931 in the same hollow. This may mean that the species has just become established, although it should be kept in mind that the summer of 1930 was comparatively dry, while that of 1931 was very wet. On the other hand,

however, this portion of the Pack Forest is low and moist, and there was no lack of other fleshy fungi during 1930.

As an alternative to the foregoing, it is possible that this species has been found before but has been interpreted as another plant. *B. sordidus* was described by Frost from Vermont and has been reported from Ohio by Morgan. The distinguishing



FIG. 1. Sporophore of *Boletus porphyrosporus* Fries in Pack Forest, near Warrensburg, N. Y. The color of the pileus is not so light as it appears in this photograph, which was taken in dark woods with the light strongest from above. It would appear from this picture that the sporophore had been removed and stood up on top of the leaf litter, but such is not the case. The somewhat bulbous base was entirely above ground as shown here.

characteristics are given as a dirty-brown color of the pileus, the changing of the white flesh to reddish or greenish, a brownish stipe streaked, somewhat flexuous and striate, and large angular mouths of the pores. These characteristics are strongly suggestive of *B. porphyrosporus* in which the pores may become large and more or less angular in late maturity. The only differences between the two as can be pointed out are the smaller size of *B. sordidus*, its glabrous stipe, its yellowish-brown or dirty-brown spores without purplish tints, the slightly smaller size of the

spores and the failure to stain white paper when a print is made. The size of the spores of *B. sordidus* (10–12  $\mu$  long) falls within the limits of those of *B. porphyrosporus*, although most of the spores of the latter are 13–16  $\mu$  long. The only outstanding difference which could not come within the limits of the ordinary variations is the purplish tints of the spore prints of *B. porphyrosporus*. If spore prints were not examined when fresh, this difference might be overlooked. It therefore seems highly probable that *B. sordidus* is the same as *B. porphyrosporus*, which has priority.

If Fries' tribe Favosi (characterized by broad, angular tube mouths) is accepted, this species would be placed therein. It would be the only American species in this tribe unless *B. sordidus* is recognized as distinct. If one is hesitant in accepting this tribe, as was Peck, it would be placed in the Subtomentosi.

This account is presented for the purpose of bringing to light further information regarding the species if it has been found in this country before, and if not, in order to add it to the list of American boletes.

Specimens will be placed in the Farlow Herbarium at Harvard and in the Herbarium of the New York Botanical Garden. With the writer's collections at Brown University are also water color drawings.

The following description from the writer's specimens is added, inasmuch as it is more complete than can be obtained from European sources, except the recently published work by Kallenbach,<sup>1</sup> which contains excellent illustrations.

*Pileus* convex to plane, 5–11 cm. in diameter, 2–3 cm. thick.

*Surface* dry, subtomentose or minutely tomentose, smooth and soft like soft leather; in color, wood brown, buffy brown, deep olive buff, Saccardo's umber or dark olive buff,<sup>2</sup> becoming darker or blackish when handled; pellicle not separable.

*Margin* even, often rolling upward on drying.

*Context* firm, somewhat tough, white, slowly becoming tinged with red or reddish brown and occasionally purplish blue where cut or wounded; slightly farinaceous in taste; expressed sap staining white paper greenish or bluish-green.

<sup>1</sup> Kallenbach, Franz. Die Pilze Mitteleuropas. Band I. Die Röhrlinge (Boletaceae). Leipzig.

<sup>2</sup> Ridgway, Robert, Color Standards and Nomenclature.

*Tubes* adnate and usually slightly depressed around the stipe, ventricose, 10–15 mm. long; slowly changing to bluish green when exposed to the air and finally to reddish brown; mouths 7–8 to 5 mm., rounded to elliptical and sometimes slightly irregular, in color wood brown to tawny olive when young, with a tinge of olivaceous in places, becoming vandyke brown when old or where handled; edges entire.

*Stipe* central, tapering upward, sometimes uneven or ventricose, surface furfuraceous or minutely pulverulent under a lens, cortex cracking and rolling back or splitting in various ways (often in a zigzag manner); whitish to brownish, becoming dark brown or black where handled or with age; solid, whitish within but sometimes brown at the base, turning black with age; 6–15 cm. long, 1–2.5 cm. thick.

*Spores* in mass light purple drab when fresh and light cinnamon drab when older; white paper on which spore print is made is usually stained greenish or bluish green from the sap which escapes from the context through the tubes; elliptical to elliptical-fusiform, with porphyry reddish epispore and greenish center,  $10.5\text{--}20.5 \times 5.3\text{--}6.5$  (mostly  $13\text{--}16 \times 5.5\text{--}6 \mu$ , with only a few of the extreme length of 19 or  $20 \mu$ ).

*Odor* not conspicuous, although somewhat unpleasant at times. Occurring singly in low moist area under mixed hardwood and conifer stand (especially hemlocks); July to September 16th. Pack Forest, Warrensburg, N. Y.

Illustrations: Michael-Schulz.	Führer für Pilzefreunde 1: 283.	1927
Kallenbach, Franz.	Die Pilze Mitteleuropas Band I. Die Röhrlüche (Boletaceae). Lieferung 10, Taf. 26.	1930

The tubes of this species are not as angular as described by Michael and Kallenbach, the odor is not so unpleasant or musty, the spores are rarely as long or as broad, and the edges of the tubes are not jagged as given by Kallenbach. Otherwise, the descriptions by these German writers fit our specimens.

## BOLETUS LUTEUS AND BOLETUS SUBLUTEUS

There has been much confusion over these species in this country. Peck reported the former as rare in New York and described *B. subluteus* as differing from *B. luteus* by "its smaller size, more slender stem and glutinous collapsing veil" and being glandular dotted both above and below the annulus, whereas the latter was dotted only above the annulus. Murrill united these two species (N. Am. Fl. 9: 155) under the name *B. luteus* and described the stipe as being glandular dotted above and below the annulus. Peck in the above mentioned bulletin, said of *B. luteus* that "in some specimens the annulus appears to sheath the lower part of the stem," although in an earlier publication he stated that this was a common feature. Murrill says nothing of this in any place that the writer can find, although his upper right hand figure of a young plant on plate 2 in volume 12 of MYCOLOGIA (opp. p. 59) apparently faintly shows what appears to be a veil sheathing the stem.

These discrepancies have left a student in confusion, especially inasmuch as the writer has continually found a few specimens of what appears to be *B. luteus* in a Scots pine plantation near Minerva, N. Y. The pileus of these was a deep chestnut in color, the stipe was glandular dotted both above and below the annulus, with a conspicuous sheath of the stem which became shredded as the plants grew in size, and with the upper part of the stem reticulate from the decurrent walls of the tubes in most specimens. This latter feature has been mentioned by neither Peck nor Murrill as far as can be found.

Kallenbach's recent description (p. 45) notes all these features and is very satisfying. He likewise included *B. subluteus* Peck in *B. luteus* Fries. This may be the proper disposition of Peck's *B. subluteus*, although in justice to Peck's mycological acumen, it may be said that the writer has found this form, readily distinguishable by the characters mentioned by Peck (see above), as one of the four most common boletes in the Adirondacks—the others being *B. granulatus* L., *B. scaber* Fries and *Boletinus pictus* Peck. The form which he calls *B. subluteus* can be found all summer in any season under white pine growth. The writer

has never found it with a sheathing veil and is inclined to consider it a distinct species as maintained by Peck.

#### BOLETINUS SPECTABILIS

This species was first found by Peck near North Elba, in the Adirondacks, and was placed in the genus *Boletus*. He later collected the same species near Indian Lake. In connection with these specimens he said that this species with *Boletinus pictus* and *B. paluster* formed a natural group of allied species, yet he left it in the genus *Boletus*. In his monograph, also, he left it in *Boletus*. Murrill changed it to the genus *Boletinus*, as *Boletinus spectabilis* (Peck) Murrill.

This change seems to be a reasonable one. The writer collected these plants several times between Indian Lake and Blue Mt. Lake during the past summer and all of them showed to some extent at least, the *Boletinus* characters. In some of them the tubes were definitely arranged in a radiating manner, and veining was common. In other plants there was only a suggestion of radiating tubes and veining. On the other hand, in specimens collected near Warrensburg, N. Y., late in the fall, these characters were hardly discernible at all. It may be said, however, that many specimens of *Boletinus pictus* can be found which show no veining even in young forms, although the tubes are of the *Boletinus* type.

In view of the apparent relationship of these three species and the usual presence of the necessary characters, it seems best to follow Murrill's change.

#### CERTAIN LARICOPHILOUS SPECIES OF BOLETUS

There has been considerable difficulty with most of the Boletes found growing under or near larch trees. There seems to be no question about the specificity of *Boletinus spectabilis* and *B. cavipes*. The writer has had no difficulty with *Boletus Clintonianus* in the Adirondacks, although Kallenbach would reduce this name to synonymy. On the other hand, one has difficulty with certain of the other species. Peck has recognized *B. laricinus* Berk. and named *B. elbensis*. Frost named *B. serotinus*, which Peck said was probably a variety of *B. elbensis*.



Murrill (N. Am. Fl. 9: 156) remarked that *B. elbensis* Peck appeared to be *Boletinus glandulosus* Peck, which was probably the same as *Boletus aeruginascens* Secr. and which is a synonym of *B. viscidus* Fries (not *B. viscidus* L.).

Kallenbach has removed *B. Clintonianus* Peck from this tangle by making it a synonym of *B. flavus* Fries ex With. which he prefers to call *B. elegans* Fries (not Schum.). He has then made *B. aeruginascens* Secr., *B. laricinus* Berk., *B. serotinus* Frost and *Boletinus grisellus* Peck synonyms of *B. viscidus* Fries.

The writer is not qualified to pass upon the change with regard to *B. Clintonianus*, because there seems to be some question with regard to the occurrence of the form called *B. flavus* Fries ex With. (or *B. elegans* Fries) in this country. Likewise, the writer cannot pass upon *Boletinus grisellus*, which is given as found only once near Natick, Mass., although it must be said that Peck's description fits that of Kallenbach for *B. viscidus*. Peck placed the species *grisellus* in *Boletinus*, although he said nothing about the tubes and veins.

With regard to the other loricophilous species, it has been very difficult to make collections of large numbers of these plants found under larch trees in Peck's own localities fit the descriptions of any one of *B. laricinus*, *B. elbensis*, *B. serotinus* or *B. grisellus*. Individuals of any one collection from the same spot could be put in different ones of the four. Therefore, the grouping of these along with *B. aeruginascens* under *B. viscidus* Fries seems at present to be a satisfactory treatment.

#### BOLETUS RHODOXANTHUS

A plant has been collected occasionally in the Adirondacks which it has been difficult to identify. It is apparently near to *B. purpureus* Fries of the Luridi, although its tubes do not always have red mouths. There has been some difference of opinion with regard to the occurrence of *B. purpureus* in this country. Peck cites collections of it from North Carolina, Minnesota, and New York, but Murrill did not recognize the species. Kallenbach has split *B. purpureus* into *B. rhodoxanthus* (Krombh.) Kallenb. and *B. erythropus* Pers. (not Fries). The writer feels that this rearrangement will aid in the proper placing of the species formerly hard to identify as *B. purpureus*.

Our plants seem closely to fit the description of *B. rhodoxanthus*. It was found in July and August in hardwood stands of oak, beech, and maple near South New Berlin, N. Y. Before definitely placing this in the list of American species, however, the writer prefers to await study of additional collections. In the meantime it is hoped that this announcement may elicit further information upon forms formerly placed in *B. purpureus*.

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## SOME LICHENS OF OREGON<sup>1</sup>

V. GYELNIK

In December, 1930, I received some lichens from F. P. Sipe, Corvallis, Oregon. These were sent me in response to a request for material of the genera *Alectoria*, *Peltigera*, and *Nephroma*, which I am revising. The material received is of sufficient interest to justify publishing it. Part of each specimen listed is deposited in my herbarium, and part in the herbarium of Oregon State Agricultural College, at Corvallis. Except where otherwise stated, the lichens have been collected by F. P. Sipe.

1. *PELTIGERA CANINA* (L.) Willd. f. *SPONGIOSA* Tuck.  
Along roadside, on soil, Corvallis, Benton County.
2. *P. CANINA* (L.) Willd var. *RUFESCENS* (Weis.) Willd.  
On shallow soil, Union Creek, Jackson County.
3. *P. DOLICHORRHIZA* Nyl.  
At base of tree, Swim, Clackamas County, and on soil, Waldport, Lincoln County.
4. *P. HAZSLINSZKYI* Gyel.  
On soil, near Mt. Hood, Clackamas County.
5. *P. MEMBRANACEA* (Ach.) Nyl. f. *PELLUCIDOIDES* Gyel.  
On moist shaded stream bank, Mt. Hood, Clackamas County.
6. *P. MEMBRANACEA* (Ach.) Nyl. f. *SZATALAE* Gyel.  
On soil, Waldport, Lincoln County.
7. *P. MEMBRANACEA* (Ach.) Nyl. f. *FIBRILLOIDES* Gyel.  
On moss, Triangle Lake, Lane County.
8. *P. POLYDACTYLA* (Neck.) Hoffm.  
On fallen logs, Breitenbush, Marion County.
9. *P. POLYDACTYLA* (Neck.) Hoffm. var. *SUBNERVOSA* Gyel.  
On fallen log, Rhododendron, Clackamas County.
10. *P. PRAETEXTATA* (Floerk.) Zopf. var. *SUBCANINA* Gyel.  
On decaying stump, Corvallis, Benton County, and on moss, Union Creek, Jackson County.

<sup>1</sup> This paper has been emended in respect to collection data and edited by F. P. Sipe for publication in MYCOLOGIA.

11. *P. SCUTATA* (Dicks.) Leight. var. *COLLINA* (Ach.) Gyel.  
On soil, Mt. Hood, Clackamas County.
12. *P. VARIOLOSA* (Mass.) Gyel.  
On rocks, Union Creek, Jackson County, and on trees,  
Rhododendron, Clackamas County.
13. *P. VARIOLOSA* (Mass.) Gyel. f. *CRISPA* (Vain.) Gyel.  
On soil, Waldport, Lincoln County.
14. *P. VARIOLOSA* (Mass.) Gyel. var. *ductylodes* (Nyl.) Gyel.  
On soil, near Mt. Hood, Clackamas County.
15. *P. VARIOLOSA* (Mass.) Gyel. f. *BRITANNICA* Gyel.  
On trees, near Rhododendron, Clackamas County.
16. *P. VENOSA* (L.) Baumg.  
On soil, near Mt. Hood, Clackamas County.
17. *ALECTORIA SARMENTOSA* Ach.<sup>2</sup>  
On conifers, near Mt. Hood, Clackamas County.
18. *NEPIIROMA RESUPINATUM* (L.) Ach. var. *HELVUM* Mass.  
On willow trees, near Mt. Hood, Clackamas County, and  
on maple, Breitenbush, Marion County.
19. *N. RESUPINATUM* (L.) Ach. f. *GRISESCENS* Gyel.  
On dead tree, near Rhododendron, Clackamas County.
20. *N. RESUPINATUM* (L.) Ach. f. *RAMEUM* Schaer.  
On maple, near Mt. Hood, Clackamas County.
21. *N. resupinatum* (L.) Ach. f. *inaequalis* Gyelnik forma nov.<sup>3</sup>  
On alder, Union Creek, Jackson County.
22. *N. TROPICUM* (Müll. Agr.) Zahlbr.  
On maple, Breitenbush, Marion County.
23. *N. Sipeanum* Gyelnik sp. nov.<sup>4</sup>

This species differs from *N. Schultz-Korthii* Gyel. in having the thallus at the back of the apothecia isidiate, the apothecia subentire at the margins, and not proliferous. *Thallus* glabrous above, smooth, isidiöse; margin proliferous, fimbriately isidiöse;

<sup>2</sup> Thallus K—, C—, KC+ flavus demum lente rubescens. Fert.—.

<sup>3</sup> Similis var. *helvo* Mass. sed thallus subtus sat venosorugosus.

<sup>4</sup> *Nephroma Sipeanum* sp. nov. A *Nephroma Schultz-Korthii* Gyel. different thallo in dorsis apotheciorum isidiato, apotheciis ad margines subintegris, non proliferis. Thallus superne glaber, levis, isidiosus, ad marginem proliferus (fimbriato-isidiosus) in dorsis apotheciorum pubescens et isidiosus, subtus tomentellus, epapillosus. Margines thallini apotheciorum subintegri. Medulla alba, K—, KC+ flava.

apothecia pubescent and isidiose at the back, tomentulose without papillae below. The small thalli of the apothecia have subentire margins. Medulla white, K—, KC+ yellow. Spores fusiform to ellipsoid, unilateral, 3-septate, guttulate, brown,  $21-25 \times 6-8 \mu$ .

On oak tree, Eagle Point, Jackson County. Collected by L. N. Goodding.

*N. Sipeanum* is named in honor of Prof. Frank P. Sipe, Corvallis, Oregon.

24. *N. PARILE* Ach. f. *HYBRIDUM* Gyel.

On *Rhododendron*, Breitenbush, Marion County.

25. *N. FILARSZKYANUM* Gyel. f. *EUVULGARE* Gyel.<sup>5</sup>

On ash tree, Corvallis, Benton County.

26. *N. LUSITANICUM* Schaer.

On ash tree, Corvallis, Benton County.

MAGYAR NEMZETI MUSEUM NOVENYTANI OSTÁLYA,  
BUDAPEST, HUNGARY

<sup>5</sup> Medulla alba, K—, KC—.

## THE SEXUAL FUNCTION OF THE MICROCONIDIA IN CERTAIN DISCOMYCETES<sup>1</sup>

F. L. DRAYTON

During the past century, frequent references have been made to structures in some of the Discomycetes which have been either termed microconidia or spermatia. Speculation has been rife as to their function. Like the pycniospores of the rusts, these bodies were relegated to the ephemeral realm of functionless male cells, problematic true spores, and the like. Failure to establish the true rôle of these bodies is the more remarkable, since the sexual function of structures homologous with the microconidia has been generally accepted for certain of the discomycetous lichens, and for some of the Laboulbeniales. Tulasne, who was the first to describe these bodies in the Discomycetes,<sup>2</sup> designated them as spermatia or conidiola " . . . believing that sometime or other it would be demonstrated that there resided in them a certain force or nature like that of pollen." <sup>3</sup> In spite of the disconcerting evidence that many minute conidia, morphologically indistinguishable from the conidiola of the Discomycetes, germinate and reproduce the fungus, Tulasne apparently never entirely abandoned the belief that these non-germinating conidiola function, like the spermatia of the lichens, as male sperms. Whetzel,<sup>4</sup> in discussing the microconidia of *Sclerotinia Duriacana* (Tul.) Rehm, suspected the true rôle of these bodies when he states, "They more probably function as do the spermatia of the rusts"; and this is here shown to be the case.

In the descriptions of many species, especially those of *Sclerotinia* and *Botrytis*, microconidia have been well characterized. Briefly, they are globose, 2-4  $\mu$  in diameter, and are produced

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<sup>1</sup> Tulasne, L. R. & C. *Selecta Fungorum Carpologia* (Transl.) 3: 183.

<sup>2</sup> *Ibid.* 1: 183.

<sup>3</sup> Whetzel, H. H. North American species of *Sclerotinia* II. Two species on *Carex*, *S. Duriacana* (Tul.) Rehm, and *S. longisclerotialis* n. sp. *Mycologia* 21: 5-32. 1929.

successively from small, fasciculate, Indian-club-shaped conidiophores, arising from a single hyphal cell. The microconidia are produced in large numbers in each cluster and are embedded in a mucilaginous matrix which on drying becomes waxy. Most investigators, including the writer, have failed to obtain any appreciable growth through the germination of microconidia. The few cases where such successful germination is reported, remain to be satisfactorily explained.

In the course of a taxonomic study of a number of sclerotium-producing fungi affecting bulbous and cormous ornamentals, the development of apothecia by *Sclerotium Gladioli* Massey <sup>5</sup> has been induced by means of placing the microconidia of one thallus on certain structures which develop on another thallus. This process may be called "spermatization," and it will be so designated throughout this paper. The ascospores obtained from these apothecia have been cultured and the resulting growth is identical in every respect with that of the original cultures. These fruiting bodies are typical of those found in *Sclerotinia*, and this fungus must now be placed in that genus.

Seven isolates of *S. Gladioli* were used, four from the garden gladiolus, one from a variety of the *Gladiolus nanus* type, one from crocus, and one from freesia. Clonal cultures were obtained by single hyphal tip isolations, and the identity of every isolate established by successful inoculation of gladiolus corms.

On transferring these isolates to suitable culture media, and subjecting them to proper conditions of moisture and temperature, a discontinuous layer of sclerotized tissue, along with scattered sclerotia, are formed over the surface of the substratum. From this crust receptive bodies develop which are variously shaped, but more or less columnar, about 1 mm. in height, brown or light brown, and covered with short protruding hyphae. These structures, when spermatized with microconidia from a reactive isolate, and subjected to proper conditions of temperature and moisture, promptly develop into apothecial fundaments, and on exposure to light, expand into mature apothecia. Receptive bodies, treated identically, but on which no microconidia

<sup>5</sup> Massey, L. M. Dry rot of gladiolus corms. *Phytopathology* 18: 519-529. 1928.

were placed, or spermatized with a non-reactive isolate, proliferate to some extent, and may attain a height of 3 mm., but never develop into apothecia. After many modifications of the technique, it is now possible to obtain mature apothecia in 6-7 weeks from the time when the clonal culture is transferred to the substratum employed.

Some 127 such spermatizations have been made, using the receptive bodies and microconidia of the seven isolates in all possible crosses. In addition, about a fourth that number of cultures has been used as checks. It was discovered that only one of the seven isolates is of opposite reactive potentiality to the others. That is, apothecia are produced only when the isolate from crocus is used as a source of microconidia to spermatize any of the other six, or when the microconidia from any of the other six are used to spermatize the receptive bodies of the crocus isolate. It was also demonstrated that the receptive bodies of each isolate do not react with their own microconidia; that is, they are all self-sterile.

We therefore have here two strains or races, one represented by the isolate from crocus, the other represented by the remaining six isolates. These two races represented in the present collection of seven isolates are reciprocally interfertile, the six isolates representing one race are reciprocally intersterile. All isolates in both races are self-sterile.

Thus *S. Gladioli* presents in this respect essentially what Craigie has found to be the situation in the rusts. The sexual mechanism is strikingly different from that reported in the higher Basidiomycetes by Buller and his co-workers, and by Dowding<sup>6</sup> in *Ascobolus*, in that diploidization apparently does not result from vegetative fusion. This was demonstrated by the use of paired cultures, employing pairs of interfertile isolates. Under optimum conditions, no apothecia developed as a result of the intermingling of the hyphae of the two thalli, even though receptive bodies were abundantly produced by each isolate. Upon cross-spermatization, however, apothecia promptly devel-

<sup>6</sup> Dowding, E. Silver. The sexuality of *Ascobolus stercorarius* and the transportation of the oidia by mites and flies. *Annals of Botany* 45: 621-637 1931.



oped. Paired cultures of intersterile isolates gave no apothecia, even of course when cross-spermatized.

It is highly probable that this sexual mechanism is operative, with perhaps slight modifications, in all of the spermatia-producing Ascomycetes, including in the term spermatia, microconidia of the type here described.

Certain phases of the cytological aspect of this problem are being undertaken, and it is expected that in the near future a more comprehensive paper will be published dealing with the technique employed, and a more detailed description of the structures concerned.

This investigation has been conducted under the direction of Professor H. H. Whetzel. The valuable suggestions and stimulating encouragement given by him, and also by Professor L. M. Massey are gratefully acknowledged.

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## NOTES AND BRIEF ARTICLES

On January 23, 1932, Joens Elias Fries died at Birmingham, Alabama. He was born in Sweden in 1877 and educated in the University of Stockholm, coming to the United States in 1903, as an electrical engineer. Although he was not a professional mycologist he had been a subscriber to MYCOLOGIA for a number of years and prepared two fungus charts, copies of which are on file in the library of The New York Botanical Garden.

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### THE CLASSIFICATION OF PYTHIUM

Mr. Sideris has recently granted<sup>1</sup> the correctness of my contention<sup>2</sup> that *Nematosporangium* has no standing taxonomically<sup>3</sup> and hence, the matter of what shall be called *Pythium* becomes a subject, not for individual apologetics but for the committee on *nomina conservanda*.

Concerning his statement that I did not read very carefully the description of *Pythium monospermum*, the type species of the genus, or else I would have noticed that ". . . the hyphae of this organism possessed bud-like outgrowths which came to be known by later investigators as prosperangia," and further, that "the German text in connection with the lobulate prosperangia of *P. monospermum* reads as follows: '. . . Fäden oft mit vielen Kurzen annähernd rechtwinkelig ansetzenden Seitenästen . . .'," allow me to say the following:

I carefully perused Pringsheim's<sup>4</sup> description of his fungus but could find no such statement. Further search, however,

<sup>1</sup> Science 74: 596, 1931.

<sup>2</sup> Science 73: 41, 1931.

<sup>3</sup> Brussels Code, Sect. 6, Art. 45, p. 44. "When a genus is divided into two or more genera, the name must be kept and given to one of the principal divisions. If the genus contains a section or some other division, which judging by its name or its species, is the type or the origin of the group, the name is reserved for that part of it." . . .

<sup>4</sup> Jahrb. Wiss. Bot. 1: 284, 1858.

revealed in Fischer<sup>5</sup> the following: "Mycelium saprophytisch auf im Wasser faulenden Fliegen und Mehlwürmern, bildet 1.5–2 cm. breite Rasen von *Saprolegnia*-habitus, mit zarten, 2–5  $\mu$  breiten, sehr langen und verästelten Faden, oft mit vielen kurzen, annähernd etc. . . ." Mr. Sideris's quotation is *not*, therefore, as one might suppose, from the original source, Pringsheim, but from Fischer, and further, the latter writer's text was not "in connection with the lobulate prosperangia of *P. monospermum* . . .," but the *mycelium*. Nowhere in Pringsheim was I able to find evidences of inflated portions of the mycelium being evacuated through a filamentous discharge tube. Furthermore, if Pringsheim's figures of the sporangia be examined (PL. 21, FIG. 13)—and from so keen an observer they can hardly be considered atypical ones—not even a suggestion of inflated elements can be found. Finally, irregularities of the mycelium need not necessarily always be concerned—as the writer recently has shown<sup>6</sup>—with sporangial activity, and Mr. Sideris's assumption that Fischer's account of the mycelium of Pringsheim's species contains references to prosperangia seems unwarranted by the evidence at hand.

For the above reasons, I am forced to adhere to my original contention, namely, (1) that *Pringsheim's* fungus possessed entirely filamentous sporangia; (2) as it (*P. monospermum*) is the type species of the genus, if *Pythium* in its inclusive sense is to be split, there is at present no taxonomic justification for *Nematosporangium*; (3) some name must be given the lobulate and sphaerosporangial forms other than *Nematosporangium* and *Pythium*.

The astonishment evinced by Mr. Sideris with respect to the establishment of *Rheosporangium* (in spite of the existence of other well established, closely related forms then classed in *Pythium*) seems to indicate that he has not read the statement by the author<sup>7</sup> (p. 289) of that genus, that the latter was moved to erect it because he found no related organisms described in Minden<sup>8</sup>—a work which does not include the Peronosporaceae,

<sup>5</sup> Kryptogamenfl. Deutsch. etc. 14: 399, 1892.

<sup>6</sup> Mycologia 23: 191, 1931.

<sup>7</sup> Journ. Agr. Res. 4: 279, 1915.

<sup>8</sup> Kryptogamenfl. Mark Brandenburg 5: 209, 1915.

of which *Pythium* is a member. The fact remains however, that *Rheosporangium* appears to be the first valid genus name applied to a lobulate species of *Pythium*.

In closing his reply to my suggested treatment of *Pythium*, Mr. Sideris answers my criticism of his failure to separate filamentous and lobulate sporangial forms with the statement that he has ". . . never seen any species of *Nematosporangium* (*P. monospermum* type of organisms) lacking the lobulate prosporangia. . . . These bodies vary in size and number in different species, but they are present, nevertheless, in all species." And also, if my proposal were followed (in placing lobulate forms in *Rheosporangium*, etc.), there ". . . would not be left any more members for *Pythium*." No doubt Mr. Sideris has not observed species with entirely filamentous sporangia, but he need only to consult the figures of sporangia given by Pringsheim, Schenk, Ward, Gobi, Raciborski, de Wildemann, Kanouse and Humphrey, Matthews, Sparrow, etc., to see a number of them portrayed. There seems little danger of the extinction of *Pythium* if the latter genus is restricted to entirely filamentous sporangial forms so long as the following organisms are known to science: *Pythium monospermum* (of Prings.), *P. tenue* Gobi, *P. dictyosporum* Racib., *P. gracile* Schenk (sensu lat. Matthews), *P. perniciosum* (in part), *P. daphnidarum* Pet., *P. afertile* K. & H., *P. papillatum* Matt., *P. angustatum* Spar., *P. adhaerens* Spar.

In closing, let me say that my original idea in criticising Mr. Sideris's classification was not for the purpose of proposing one of my own. Adhering to this idea, I made no new combinations which would validate it. I do not believe that sharp lines of demarkation delimit groups here any more than they do in other classes of organisms. I did intend, however, to bring to the attention of mycologists and pathologists the anomalous situation extant with respect to the usage of the generic names *Nematosporangium* and *Pythium*.

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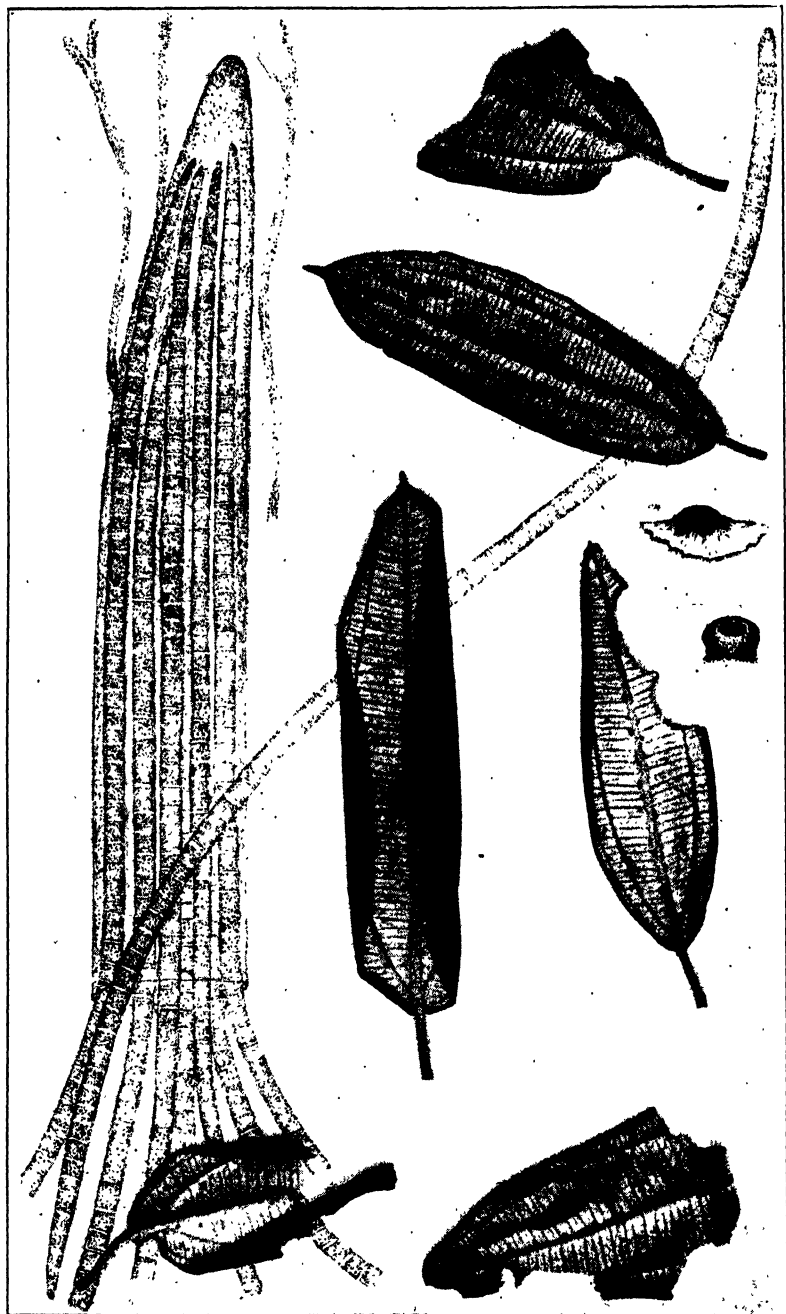
## THE TYPE OF PESTALOTIA

In the Genera of Fungi, p. 384, Clements and Shear cited *Pestalotia funerea* Desm. as the type of the genus and in the same line cited De Notaris (1839) as the author of the genus. What a strange coincidence! *P. pezizoides* De Notaris (1839) is the original species, *P. Guepini* Desm. (1840) the second and *P. funerea* Desm. (1843) the third in the order of publication. An inquiry to Dr. Shear to learn his reason for selecting *P. funerea* Desm. instead of *P. pezizoides* De Notaris brought forth the reply that "according to the revised rules the type of a genus should be a common or well known species which will fix the generic name according to general usage." "That is the reason we selected *P. funerea* instead of *P. pezizoides*." All three species are common and well understood, the first two much more so than the third if one wishes to accept as a criterion the number of and the determination of the specimens in the various exsiccatae sets of fungi. The name *P. funerea* Desm. has been applied to almost everything and has been very much misunderstood and misused. This, however, is no criticism of its use for the purpose stated by Shear.

The genus *Pestalotia* was monotypic when first described. The original species *must absolutely remain the type species*. Even though the type species had never again been collected it must still remain the type. The strictest respect for this rule is very important if we hope to maintain a healthy state of affairs in systematic mycology.

E. F. GUBA





GODRONIA PARASITICA

# MYCOLOGIA

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## PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XVII. A NEW SPECIES OF *GODRONIA*<sup>1</sup>

FRED J. SEAVER

(WITH PLATE 9)

In working over the family Cenangiaceae preparatory to a monograph of the genus the writer has encountered some apparently undescribed species. Perhaps no genus of the family is more interesting than the genus *Godronia*, which is characterized by its filiform spores. The apothecia in this genus are usually strongly constricted above so that when young they closely resemble a perithecium with a large ostiole, although they often become more expanded at maturity. So closely do they resemble a *Pyrenomycete* that one species at least was originally placed in that group although the consistency is fleshy or leathery rather than carbonaceous.

In working over some tropical fungi the writer has encountered a very interesting species on the leaves of *Tetrazygia*. The apothecia themselves are so minute that they appear as delicate specks on the under sides of the leaves. When magnified, however, they show the unmistakable characters of the genus indicated above. The species is rather unique in that it is parasitic while most of the other species of the genus are strictly saprophytic. Another outstanding character of the species is the unusually large size of the asci and spores, which are several times larger than those of any of the other species of the genus

<sup>1</sup> This paper is preliminary to a monograph of North American Cup-fungi (inoperculates), a companion volume to North American Cup-fungi (operculates), which was published by the author and issued in December, 1928.

[MYCOLOGIA for May-June (24: 265-352) was issued May 2, 1932]



examined in spite of the small size of the apothecia. In fact, the asci were so long that they could not be drawn on the ordinary sized plate and it was barely possible to get the entire length of the spore by placing it diagonal as shown in the accompanying illustration. The following is the diagnoses of the species:

**Godronia parasitica** Seaver, sp. nov.

Apothecia scattered on the under side of the living leaf, especially along the midrib, erumpent, at first globose, becoming expanded but with the mouth constricted, black, reaching a diameter of .3–.5 mm.; hymenium dingy, more or less concealed; asci clavate, reaching a length of 250–300  $\mu$  and a diameter of 27  $\mu$ ; spores filiform, nearly as long as the ascus and about 4  $\mu$  thick, many-septate, the number of the septa difficult to determine but more than 50 have been counted reaching a length of 250  $\mu$ ; paraphyses slender and rather freely branched.

Apotheciis solitariis, hypophyllis, erumpentibus, primo subglobosis, dein urceolatis, nigris, .3–.5 mm. diam.; ascis subcylindraceutis, octosporis, 27  $\times$  250–300  $\mu$ ; sporis filiformibus, multiseptatis, rectis vel leniter curvulis, 4  $\times$  200–250  $\mu$ ; paraphysis filiformibus, ramosis.

On leaves of *Tetrazygia longicollis*.

TYPE LOCALITY: Marmelade, Republic of Hayti.

DISTRIBUTION: Known only from the type locality.

This is described from material collected by Mr. George V. Nash, August 25, 1903 (Nash 793). The species is distinguished by its huge asci and spores.

EXPLANATION OF PLATE 9

Photograph of several leaves of *Tetrazygia longicollis*, slightly enlarged, showing the minute apothecia with much enlarged sketch of two apothecia at the extreme right. At the left, drawing of a portion of an ascus with paraphyses and spores. Diagonally across the plate, a single spore removed from the ascus. Ascus, paraphyses and spores highly magnified.

# MONOGRAPH OF THE GENUS *PESTALOTIA* <sup>1</sup>

## PART II

E. F. GUBA

(WITH 4 TEXT FIGURES)

### INTRODUCTION

In spite of the unique spore characters which clearly distinguish the genus *Pestalotia* from all other genera of fungi inexcusable mistakes have been made in the incorrect assignment of many species to this genus. Also, the eagerness with which some mycologists have accepted the opportunity to describe new species without making any serious effort to learn of those already existing has proved a serious evil. Much unnecessary synonymy has resulted which has required careful study to correct. The form and size of the conidium, the number, size and contrasted color of the colored cells, the number and length of the setae and the length of the pedicel offer a variety of distinguishing characters but these were given such inadequate consideration as to render many of the descriptions useless. As a result of such a state of affairs the incorrect designation of species is very prevalent in phytopathological and mycological literature.

### DEFINITION OF SPECIES

The aim in this study has been to regard all good species as distinct individuals with regard to morphology and size but independent of host considerations. An accurate separation of species according to morphological characters in such a large group of individuals as the genus *Pestalotia* admittedly is difficult

<sup>1</sup> For Part I see *Phytopathology* 19: 191-232, 1929.

The writer is gratefully indebted to Dr. C. W. Dodge of the Missouri Botanical Garden for helpful suggestions in the preparation of this manuscript and to Dr. David H. Linder of Harvard University for preparing the Latin diagnoses accompanying the new species.

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and could be greatly improved with some knowledge of physiological characters. However, since only dead type specimens are available and the utmost significance is attached to types only macroscopical and morphological characters and size could be employed as a basis for defining species. My studies show that the species are closely restricted to one host or several hosts in related genera. The identity of the host, consequently, has proved convenient in the determination of species at least, at present, in the absence of a complete conspectus of the genus.

The question frequently arises as to whether species of *Pestalotia* differ sufficiently morphologically to render them capable of definition. This feeling is entertained by many who have attempted to identify species using as guides earlier compilations, list and texts of fungi and even the original type descriptions. These compilations were prepared from type descriptions, occasionally reproduced in other publications and often emended to include forms on several hosts. Usually they are too abstract to give a proper representation of the type. Most of the original descriptions are carelessly and inaccurately prepared and inadequate to be of any use. This state of affairs has discouraged the efforts of taxonomists and most of us have been content to accept such names as *P. Guepini* Desm. and *P. funerea* Desm. for almost everything. My efforts have been applied to correct this situation and much work has already been accomplished in the completion of Parts I and II of this monograph.

The variety of characters and size peculiar to the conidia of *Pestalotia* provide a reliable means of separating species. Truly, morphological peculiarities occur but La Rue (10) was not able to find any strain constant for any morphological aberrances of the natural type. Aberrant spores always produced normal progeny. La Rue (8) found that selection is ineffective in establishing distinct lines within pure strains of *Pestalotia* and that mutations which give rise to lines significantly different from parent lines rarely occur. The dependability of spore measurements in delimiting species is closely connected with the constancy of spore size. La Rue (9) showed that, *in vitro*, spore size in the genus *Pestalotia* is not affected by the character of the medium used, the concentration of nutrients and any

variations in temperature. My extensive study of natural specimens leads me to accept the same conclusion. I am satisfied that the species can be defined and that a comprehensive monograph of the genus can be evolved on the basis of morphological and macroscopical characters and size.

#### PESTALOTIA OR PESTALOZZIA

My use of the original generic name *Pestalotia*, in preference to the modified spelling, *Pestalozzia*, is apparently not acceptable to some of our elder mycologists. The mere fact of having become accustomed to a name certainly does not justify its retention if it is shown that the modified spelling and pronunciation are not an improvement or grammatical correction of the original name. The change from *Pestalotia* to *Pestalozzia* apparently was made by Corda (*Icones Fungorum* 5: 34. 1842) but Fairman (*Mycologia* 5: 245. 1913) was the first to return to the original spelling, being influenced by competent opinions of Dr. J. H. Barnhart, librarian of The New York Botanical Garden, and Professor Henry F. Burton of the Department of Latin in Rochester University. Dr. Barnhart rendered the opinion that *Pestalotia* is as euphonious as *Pestalozzia* and preferable to it. Dr. Burton opined that *Pestalotius* is undoubtedly the correct Latin form for Pestalozzi. Classical Latin has no 'z' sound or character except in a few words borrowed from the Greek. The 'z' or 'zz' often stands for Latin 't' or 'ti' as in Palazzo (Palatium), Arezzo (Arretium), Firenze (Florentia) and Venezia (Venetia). We are, therefore, obliged to allow the original spelling to stand. To do otherwise is a violation of the rule of priority.

#### PATHOLOGIC STUDIES

The unsettled state of knowledge regarding the biology of the species was indicated in Part I of the monograph. Since then more evidence has been published showing the limited pathologic capabilities of the species in nature.

Cortez (2) confirmed earlier knowledge that *P. palmarum* Cooke is distinctly a wound parasite capable of causing the gray blight of cocoanut in the Philippines. White (12) in other studies determined that *P. palmarum* Cooke is unable directly

to infect healthy tissue of *Howea Forsteriana* but may follow other pathogens or gain entrance through injured areas. *P. Guepini* Desm. was able to infect *Camellia japonica* only through wounds. He attributed the origin of the leaf spots commonly observed in greenhouses to sunscald. With *P. stellata* Berk. & Curt. from *Ilex opaca* the only successful means of inducing infection was by first scalding the leaves and applying a heavy spore suspension to the injured tissue. With *P. funerea* Desm. on freshly grafted *Cryptomeria* he determined that only the scions are susceptible to infection during the period the grafted stock is in the sweat boxes and that the scions may be killed before uniting with their stocks.

Kotthoff (7) was unable to infect *Azalea indica* L. (= *Rhododendron indicum* Sweet) with *P. macrotricha* Kleb. (not *P. versicolor* Speg.) which he recovered from plants shipped from Belgium and therefore believed that the fungus was probably a weak parasite capable of infecting *Rhododendron* only when weakened by unfavorable growing conditions. White (11) showed that *P. macrotricha* Kleb. and *P. Rhododendri* Guba were capable of infecting *Rhododendron* only through injuries and that these species are weak wound parasites. Howarth and Chippindale (6) found that *P. macrotricha* Kleb. grew in tissue rendered moribund on account of wounding but that it was unable to extend such infection into healthy tissue. They concluded that *P. macrotricha* Kleb. is parasitic only in sense that it can infect and kill tissue which is already in process of dying from some other cause; against healthy tissue the fungus is completely innocuous.

Howard (5) studied the relation of *Pestalotia* sp. to a disease of *Cinnamomum Camphora* Nees and Eberm. and found that injury from *Cryptothrips floridensis* Watson always preceded attacks of the fungus. Inoculation experiments with plants entirely free of thrips showed that this fungus was unable to attack healthy tissue but developed readily in dead portions of the host. He concluded that this fungus could be regarded only as a weak wound parasite of the camphor tree. Gäumann (4) isolated *Pestalotia* sp. (not *P. funerea* Desm.) from the basal parts of young nut trees where it caused a brown colored swelling.

He claimed to have reproduced the disease artificially but in view of so much negatory evidence of the ability of species of *Pestalotia* to cause swellings or constrictions Gäumann's results may rightfully be questioned.

It is evident from the literature dealing with the biologic relations of the species that very little if any importance can be attached to published reports crediting species of *Pestalotia* as being plant parasites. In general, species of *Pestalotia* are found in dead or dying organs resulting from other causes and usually they occur in company with other saprophytes or parasites. Until the biology of the species was investigated they were regarded as important plant parasites. Our interest in them now is largely taxonomic.

#### TAXONOMY

##### Section Quinqueloculatae Klebahn, Continued from Phytopathology 19: 191-225. 1929

31. *PESTALOTIA ADUSTA* Ellis & Ev. Jour. Myc. 4: 51. 1888.  
Sacc. Syll. Fung. 10: 486. 1892.

Acervuli amphigenous, black, minute, 70-120  $\mu$  in diameter, free, spherical or sub-conic, punctiform, sub-epidermal, erumpent on maturity, seated on pale or brown circular, sharply margined spots, not exceeding .5 cm. in diameter, and on dead areas.

Conidia 5 celled, oblong or elliptic-fusoid, usually erect, tapering to the base, 16-20  $\mu$ ; colored cells weak olivaceous, equally colored, guttulate, 11-14  $\times$  5-7  $\mu$ , only slightly constricted at septa; terminal cells hyaline, the apical cell short conic or somewhat hidden, bearing a crest of 2 to 3, usually 3 setae, erect or divergent at right angles to the spore, 5-12  $\mu$ ; basal cell short, obtuse, on a short straight pedicel, 2-7  $\mu$  (FIG. 1, 1).

On spots, dead tips, and margins of living leaves of *Prunus Cerasus* L. and *P. serotina* Ehrh.

*P. adusta* Ellis & Ev. was described on dead tips and margins of living leaves of cultivated plum trees. The tips and margins of the leaves are of a light gray color and appear as if scorched by fire. Type material was not examined but the specimens studied agree with the type description.

Specimens examined: on *Prunus serotina* Ehrh., Orient Point,

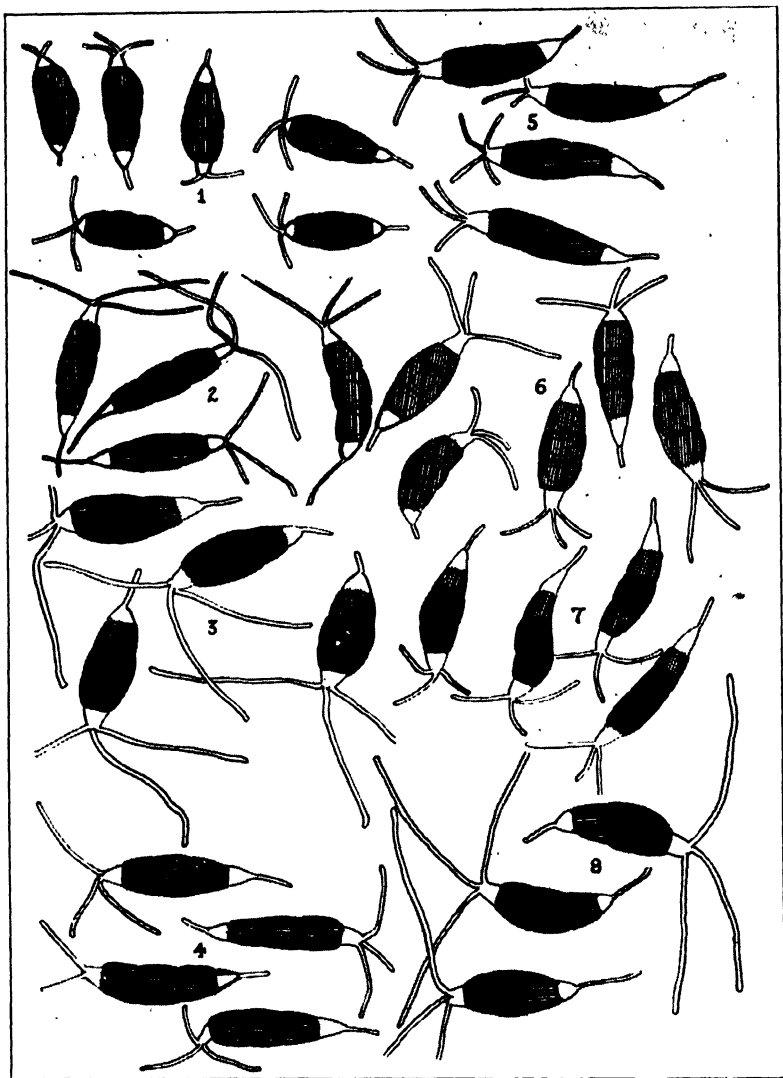


FIG. 1. Conidia: 1, *P. adusta* Ellis & Ev. from leaves of *Prunus serotina* Ehrh., Orient Point, N. Y., July, 1911, Roy Latham; 2, *P. annulata* Berk. & Curt. from leaves of *Ilex opaca* Ait., Alabama, Beaumont, Herb. Berkeley 4471, in Herb. Roy. Bot. Gard., Kew; 3, *P. clavispora* Atk., from leaves of *Quercus* sp., Auburn, Alabama, Oct. 1891, Herb. G. F. Atkinson 2288; 4, *P. microspora* Speg. from leaves of *Hedera Helix* L., Buenos Aires, Argentina, Apr. 1880, Spegazzini; 5, *P. dichæta* Speg. from leaves of *Lythrea molleoides*, Corrientes, Argentina, Febr. 1905, Spegazzini; 6, *P. disseminata* Thümen from leaves of *Eucalyptus globulus* Labill, Choupal, Portugal, June 1879, A. Moller, in Herb. Jard. Bot. Univers. Coimbra 568; 7, *P. Gaultheriae* Dearn. & House from leaves of *Gaultheria* sp., Piedro de Lino, Panama, Febr. 1918, E. P. Killip; 8, *P. longisetæ* Speg. from leaves of *Rubus fruticosus*, Conegliano, Italy, Nov. 1876, Spegazzini.  $\times 750$ .

N. Y., July 31, 1911, Roy Latham, in Herb. N. Y. State Museum; Arlington, Va., Nov. 10, 1929, R. W. Davidson, in Myc. Coll. U. S. D. A. sub *Pestalotia* sp.; on *Prunus Cerasus* L., Orient Point, N. Y., Aug. 7, 1911, Roy Latham, in Herb. N. Y. State Museum.

32. ***Pestalotia Aletridis*** (Pat.) Guba, comb. nov.

*Pestalozzina Aletridis* Pat., in Duss, Énum. Méth. Champ. Guadel. et Mart. 90. 1903. Sacc. Syll. Fung. 18: 475. 1906.

Fruiting pustules 50–150  $\mu$  in diameter, subglobose, punctiform, numerous, largely epiphyllous, at first subepidermal, later erumpent, seated on pale, dead spots with definite borders.

Conidia 5 celled, oblong or elliptic-clavate, tapering to the base, erect, 16–17  $\mu$ , median cells pale-olivaceous, equally colored, only slightly constricted at the septa, guttulate, 10–13  $\times$  5–7  $\mu$ ; apical hyaline cell short, cylindric, bearing 2 divergent setae, 6–10  $\mu$ ; basal hyaline cell usually broad conic; pedicel 1–2  $\mu$ , erect.

On dried leaves of *Aletris fragrans* L., Basse-Terre, Guadalupe, R. P. Duss in Herb. Patouillard at Harvard University.

33. **PESTALOTIA ANNULATA** Berk. & Curt. *Grevillea* 2: 155. 1874.  
Sacc. Syll. Fung. 3: 787. 1885.

Pustules punctiform, black, subglobose, mostly epiphyllous, annulate or concentrically disposed, surrounded by the torn epidermis, 125–250  $\mu$  in diameter, sometimes springing from large marginal spots with definite dark borders or in other cases generally distributed over the matrix.

Conidia long, fusiform, tapering toward the base, 5 celled, 24–30  $\mu$ , erect, sometimes prominently constricted at septa, median cells olivaceous, equally colored, 17–21  $\times$  6–8  $\mu$ , guttulate; end cells elongate, the basal long conic, tapering into an erect pedicel, 6–12  $\mu$ , attenuated downwards; apical cell long, cylindric, bearing 2–4, usually 3, widely divergent setae, 15–22  $\mu$ , frequently knobbed at the extremities (FIG. 1, 2).

On leaves of *Ilex opaca* Ait., usually on spots. Specimens examined: Herb. Berkeley 4471, Alabama, Beaumont in Herb. Roy. Bot. Gard., Kew; Ellis, N. Am. Fungi 34 sub *P. stellata* Berk. & Curt.; Herb. J. B. Ellis 2599, Newfield, N. J. sub *P. stellata* Berk. & Curt.



34. *PESTALOTIA BATATAE* Ellis & Ev. Jour. Myc. 8: 65. 1902.  
Sacc. Syll. Fung. 18: 481. 1906.

Pustules numerous, gregarious and coalescing, subcuticular, raising cuticle in hemispherical manner, roughening and blackening the surface of the tuber, forming black, thick crust.

Conidia oblong-clavate, constricted at septa, 5 celled, erect,  $23\text{--}28\ \mu$ ; median cells guttulate,  $15\text{--}18 \times 7\text{--}8\ \mu$ , the two upper umber or only slightly darker than the lowest colored cell: apical hyaline cell long, conic or cylindric, basal long, conic, dilute olivaceous; setae 3, spreading,  $7\text{--}16\ \mu$ ; pedicel short,  $2\text{--}4\ \mu$ .

On tubers of *Batatas edulis* Choisy (= *Ipomoea Batatas* Lam.), Tuskegee, Ala., Sept., 1900, G. W. Carver in Herb. Ellis, New York Bot. Gard.

Ellis stated that the conidia of *P. Batatae* Ellis & Ev. are hardly distinguishable from those of *P. Guepini* Desm. The two species according to my study are totally distinct.

35. *PESTALOTIA BICOLOR* Ellis & Ev. Bull. Torrey Club 27: 575. 1900. Sacc. Syll. Fung. 16: 1016. 1902.

Pustules amphigenous, punctate, subglobose or subcespitose, coalescing freely,  $50\text{--}125\ \mu$  in diameter, erumpent at maturity, the black contents spreading over the surface.

Conidia oblong-fusoid, 5 celled,  $19\text{--}25 \times 6\text{--}8\ \mu$ , the median cells  $13\text{--}15\ \mu$ , guttulate, the upper two colored cells darker than the lowest; setae 3 to 5, usually 3, often 4, sometimes forked,  $12\text{--}20\ \mu$ ; basal hyaline cell obtuse, apical cell cylindric or conic; pedicel erect,  $4\text{--}8\ \mu$ .

On dead leaves of *Salix* sp., Tuskegee, Ala., Dec. 12, 1897, G. W. Carver, No. 387 in Herb. Farlow, Harvard University; on *Salix nigra* Marsh., Tuskegee, Ala., Nov. 3, 1926, G. W. Carver.

Ellis emphasized the light color of the acervuli and stated that this character distinguished this species from *P. Guepini* Desm. The light colored markings on the leaves are not related to the fungus. The acervuli are punctate, distinctly black and small.

36. *PESTALOTIA CAFFRA* Sydow, Ann. Myc. 12: 266. 1914.

Fruiting pustules amphigenous, largely epiphyllous, irregularly distributed, small, erumpent, raised above the epidermis in the form of a cone, surrounded by the torn shreds of the epidermis,

collapsing and the sooty contents spreading over the matrix; seated on dry brown areas with yellowish elevated margins, largely of insect origin.

Conidia broad clavate, 5 celled, not constricted at the septa,  $24\text{--}28\ \mu$ ; median cells  $16\text{--}19 \times 8\text{--}11\ \mu$ , upper 2 colored cells umber, the lowest olivaceous; setae 3, widely divergent,  $20\text{--}26\ \mu$ , superior cell somewhat short, basal cell tapering; pedicel erect,  $2\text{--}7\ \mu$ .

On living leaves of *Mimusops caffra* E. Mey., Isipingo, Natal, Nov. 1913, E. M. Dodge in Herb. Sydow, Mus. Bot. Stockholm, Sweden.

37. *PESTALOTIA CAUDATA* Sydow, Bull. L'Herb. Boiss. II. 1: 84. 1900. Sacc. Syll. Fung. 16: 1017. 1902.

Pustules subglobose or lenticular, subepidermal, erumpent, black, scattered, later disposed in a series, confluent or hysteriform, up to 1 cm. long.

Conidia long, fusiform, erect, tapering at the ends, 5 celled,  $28\text{--}35\ \mu$ ; median cells olivaceous, the center one umber, not constricted at the septa,  $18\text{--}21 \times 6\text{--}7\ \mu$ ; apical hyaline cell long cylindric, bearing usually 3, sometimes 2 or 4 filiform setae,  $18\text{--}24\ \mu$ , rather uniform in length, divergent and reflexed; basal cell long, acute or tailed; pedicel up to  $12\ \mu$ .

On stems of Cyperaceae (gen. indet.), Serra do Itatiaia, Brazil, E. Ule 2143 in Herb. Sydow, Mus. Bot. Stockholm, Sweden. This is a very characteristic species having long, narrow conidia and a prolonged tail-like inferior cell.

38. *PESTALOTIA CLAVISPORA* Atkinson, Bull. Cornell Univ. 3<sup>1</sup>: 37. 1897. Sacc. Syll. Fung. 14: 1028. 1899.

Pustules largely epiphyllous, numerous,  $150\text{--}250\ \mu$  in diameter, scattered and loosely gregarious in places, immersed, opening by a minute pore, the spores exuding in black coils, spreading and blackening the matrix.

Conidia usually clavate-fusoid, tapering to the base, straight or unequilateral and irregular in shape and size, 5 celled,  $19\text{--}26\ \mu$ , slightly constricted at septa; upper two colored cells umber or fuliginous, the lowest olivaceous,  $14\text{--}16 \times 7\text{--}8\ \mu$ ; apical cell broad conic to cylindric, short, often somewhat hidden, bearing 3 or rarely 4 rarely branched setae,  $20\text{--}28\ \mu$ , divergent; basal cell usually acute, often swollen; pedicel  $4\text{--}7\ \mu$  (FIG. 1, 3).

On fallen somewhat green leaves of *Quercus* sp., Auburn, Ala., Oct. 3, 1891. Herb. G. F. Atkinson 2288, Cornell University.

The black pustules are generally scattered over the upper leaf surface.

39. *PESTALOTIA COCCOLOBAE* Ellis & Ev. Field Columb. Mus. (Bot.) 1: 286. 1896. Sacc. Syll. Fung. 14: 1028. 1899.

Pustules amphigenous, sparse, punctiform, largely on one surface, globose, tearing epidermis irregularly, 80–180  $\mu$  in diameter, seated on pale, circular sunken spots with brown borders, .5–2 cm. in diameter.

Conidia broad clavate, frequently unequilateral, 5 celled, constricted at septa dividing the lower colored cells, 18–22  $\times$  7–9  $\mu$ ; median cells 13–15  $\mu$ , the two upper fuliginous, opaque, the lowest umber; upper hyaline cell bearing 2, or usually 3 coarse setae, 15–27  $\mu$ ; lower hyaline cell long, tapering into an erect pedicel, 2–7  $\mu$ .

On leaves of *Coccoloba uvifera* L., associated with pale, circular spots with brown margins.

Specimens examined: Yucatan, Mexico, 1895. Millspaugh, 3 in Herb. Farlow, Harvard University, and Herb. New York Bot. Gard.; Stevens, Porto Rican F. 339b, Bogeron, Porto Rico, Feb. 15, 1913, F. L. Stevens; Herb. C. E. Chardon 484 and Herb. Whetzel and Olive 655, Mayaguez, Porto Rico, March 3, 1916, in Herb. Cornell University.

The type description mentions 3 septate spores but error is due apparently to invisibility of septa dividing the upper opaque cells. The spores of the type specimens have 3, or rarely 2 setae, not 1 to 4 as stated in the original description. Ellis (Bull. Torrey Club 27: 576, 1900) reported *P. Coccolobae* Ellis & Ev. on leaves of *Coccoloba uvifera* L. from southern Florida submitted by H. H. Hume and noted its variations from the type. The material from Florida is a distinct species.

40. *PESTALOTIA CRYPTOMERIAE* Cooke, Grevillea 12: 24, 1883. Sacc. Syll. Fung. 3: 792. 1895.

Pustules sparse, black, convex, subglobose, minute.

Conidia 5 celled, elliptic-fusoid, erect, 15–17  $\mu$ ; median cells umber or olivaceous, equally colored, guttulate, hardly constricted at septa, 10–12  $\times$  5–7  $\mu$ ; apical hyaline cell short, conic, sometimes long cylindric, bearing a crest of 3, or sometimes 2 short setae, 5–13  $\mu$ , basal cell short, obtuse or rounded at the base, supported by a short stalk, 2–5  $\mu$ .

On needles of *Cryptomeria japonica* D. Don, Aiken, So. Carolina, in Ravenel Fungi Am. Ex. 554.

Short elliptic-fusoid spores crested with 3 short setae and minute acervuli characterize this species.

41. PESTALOTIA CUPRESSINA Niessl, Hedwigia 22: 188. 1883.  
Sacc. Syll. Fung. 3: 792. 1885 = *P. funerea* Desm. 1843.  
See Phytopathology 19: 202. 1929.

On dead twigs of *Cupressus glauca* Lam. near Coimbra, Portugal. Herb. Niessl 687 and Herb. Jard. Bot. Univers. Coimbra 1132.

Fungus was described with two septate spores crested with 4-6 setae. The conidia are distinctly 5 celled and the specimen is identical with *P. funerea* Desm.

42. PESTALOTIA DICHAEETA Speg. Anal. Mus. Nac. Buenos Aires III. 13: 411-412. 1911. Sacc. Syll. Fung. 22: 1220. 1913.

Pustules amphigenous, subglobose, scattered, occasionally gregarious and confluent, innate in the parenchyma, on maturity perforating the epidermis, circinate, issuing in black coils, 200-250  $\mu$  in diameter.

Conidia usually slightly curved, long fusiform, tapering to the base, 20-25  $\mu$ , hardly constricted at the septa; median cells guttulate, olivaceous, equally colored, the two upper cells sometimes slightly darker, 13-15  $\times$  5-7  $\mu$ ; apical cell long cylindric, bearing usually 3, sometimes 2, but rarely 4 short, divergent setae, 6-14  $\mu$ ; basal cell long, tapering; pedicel 2-6  $\mu$  (FIG. 1, 5).

On weathered leaves of *Lythrea molleoides*, Bella Vista, Corrientes, Argentina, Febr. 1905, Spegazzini.

The usual number of setae is three; therefore, the specific name of the fungus is misleading. According to rules, however, it must be allowed to stand.

43. PESTALOTIA DISSEMINATA Thümen, Inst. Revista Sci. Coimbra 28: 501. 1880. Febr. 1881. Sacc. Syll. Fung. 3: 784. 1885.

*P. Eucalypti* Thümen, Inst. Revista Sci. Coimbra 28: 501-502. 1880. Febr. 1881. Sacc. Syll. Fung. 3: 785. 1885.

*P. Molleriana* Thümen, Myc. Univ. 1988, July 1881. Guba, Phytopathology 19: 223. 1929.

Fruiting pustules amphigenous, mostly epiphyllous, numerous, disseminate and usually distinct, globose-conic, projecting, pyramidal, at first covered, then erumpent, rupturing the epidermis or depositing it completely, exposing the globose black pustule, 100–225  $\mu$  in diameter, seated without order.

Conidia 5 celled, elliptic-fusoid or less often clavate, usually erect and slightly constricted at the septa, 19–25  $\mu$ ; median cells olivaceous, equally colored or the two upper sometimes slightly darker than the lowest, 13–17  $\times$  6–8  $\mu$ ; end cells hyaline, prominent, the apical cell conic, the basal cell acute and tapering; pedicel erect, short, 3–7  $\mu$ ; setae 3, usually bent sideward, 9–17  $\mu$  (FIG. 1, 6).

On dead leaves of *Eucalyptus globulus* Labill., Choupal near Coimbra, Portugal.

Specimens examined: Contr. Flor. Myc. Lust. 578 (Ser. III) in Herb. Jard. Bot. Univers. Coimbra, 568, June 1879, A. Moller; Rabenhorst, Fungi Eu. 3094, winter of 1883; Roumeguère, F. Sel. Gall. Ex. 4069, Jan. 1887; Contr. Flor. Myc. Lust. 579 (Ser. III) in Herb. Jard. Bot. Univers. Coimbra, 523 and 589, May and June 1879, A. Moller, sub *P. Eucalypti* Thümen; on dried, fallen leaves of *Eucalyptus* sp., Choupal near Coimbra, Portugal, Oct. 1879, A. Moller, in Thümen, Myc. Univ. 1988, and Roumeguère, Fung. Sel. Gall. Ex. 5167 sub *P. Molleriana* Thümen.

All the collections listed were made by Moller in Choupal, Portugal, in the period 1879 to 1887. The descriptions of *P. disseminata* Thümen and *P. Eucalypti* Thümen were published in the order given; therefore, *P. disseminata* Thümen has priority. *P. Molleriana* Thümen was described and distributed in Thümen, Myc. Univ. 1988 under date of July 1881 and, therefore, also becomes a synonym. All the specimens are identical. Thümen states that the conidia of *P. disseminata* Thümen are 5 septate but the writer's study fails to confirm this opinion. Thümen also claims that *P. disseminata* Thümen is distinct from *P. Eucalypti* Thümen by the disposition of the fruiting pustules and the dimensions of the conidia, but neither is confirmed. Thümen's descriptions of the three species are essentially alike.

44. PESTALOTIA EUGENIAE Thümen, Inst. Sci. Coimbra II. 27: 326. 1880. Sacc. Syll. Fung. 3: 785. 1884.

Acervuli epiphyllous, scattered, solitary, globose-lenticular, black, 75–120  $\mu$  in diameter, sometimes arranged concentrically,

borne under the papery epidermis and erumpent at maturity, situated in small whitish or brownish spots of different shapes with narrow purple margins, the papery interior desiccated, with age breaking and falling out in shreds.

Conidia 5 celled, elliptic-fusoid or oblong-elliptic, usually erect, 19–23  $\mu$ ; median cells olivaceous, equally colored, only slightly constricted at septa, 14–16  $\times$  6–7  $\mu$ ; end cells short conic; setae 3, divergent, 3–11  $\mu$ ; pedicel short.

On living leaves of *Eugenia uniflora* L., Contr. Myc. Lusit. 342, Ser. II, in Herb. Jard. Bot. Univers. Coimbra 204, Botanic Garden, Coimbra, Portugal, Nov. 1878, A. Moller.

45. PESTALOTIA GAULTHERIAE Dearn. & House, Ann. Rep. N. Y. State Mus. 1924. Bull. N. Y. State Mus. 266: 94. 1925.

Pustules subglobose, amphigenous, mostly hypophyllous, generally distributed and seated without order, erumpent, breaking epidermis irregularly and margined by the ruptured cuticle, 90–225  $\mu$  in diameter.

Conidia narrow-fusoid, 5 celled, curved or angled, 20–25  $\mu$ , only slightly constricted at the septa; interior cells olivaceous, the two upper somewhat darker than the lowest, 14  $\times$  16  $\times$  5–7  $\mu$ ; end cells hyaline or dilute yellow, prominent, the apical long cylindric or conic, bearing 3 or occasionally 4 setae, 6–16  $\mu$ , the basal long and acute, tapering into an erect pedicel, 4–10  $\mu$  (FIG. 1, 7).

On brown languishing leaves of *Gaultheria* sp., summit of Pedro de Lino, Panama, E. P. Killip, Febr. 24, 1918, Herb. New York State Museum, Albany.

46. PESTALOTIA GIBBEROSA Sacc. Accad. Sci. Veneto-Trentino-Istriana III. 10: 83. 1917; Philippine Agric. 8: 32–37. 1919.

Pustules amphigenous, distributed without order, circinate, 100–200  $\mu$  in diameter, erumpent at maturity and carrying away the epidermis, exposing the black contents, the sooty contents covering the matrix.

Conidia 5 celled, 15–18  $\mu$ , erect, usually equilateral, clavate or elliptic-fusoid, usually not gibbous; median cells guttulate, the two upper umber or darker than the lowest, 10–13  $\mu \times$  5–6  $\mu$ ; apical hyaline cell cylindric, narrow, crowned with usually 3 or sometimes 2 or 4 divergent setae, 9–17  $\mu$ ; basal hyaline cell broad conic; pedicel 2–7  $\mu$ , erect.

On leaves of *Litsea glutinosa* Robinson, Los Banos, Philippines, December 1913, C. F. Baker in Baker, F. Malayana 375 in Herb. Farlow, Harvard University.

47. *PESTALOTIA JAPONICA* Sydow, *Hedwigia* 38: 144. 1899.  
Sacc. Syll. Fung. 16: 1013. 1902.

Fruiting bodies subglobose or lenticular, numerous, sparse, punctiform, amphigenous, 85–175  $\mu$  in diameter, seated on dead brown marginal areas.

Conidia short, oblong or elliptic-fusoid, 5 celled, not constricted at the septa, 19–24  $\mu$ ; median colored cells 14–16  $\times$  8–10  $\mu$ , two upper cells umber, the lowest olivaceous; apical hyaline cell short conic, basal cell short obtuse or rounded; setae 3, frequently 4, straight, 12–20  $\mu$ ; pedicel erect, short, 2–5  $\mu$ .

On living leaves of *Cedrela sinensis* Juss., Botanic Garden, Tokio, Japan, Oct. 31, 1898, M. Miyoshii, in Herb. Sydow, Mus. Bot. Stockholm, Sweden.

48. *PESTALOTIA LESPEDEZAE* Sydow, *Mem. Bull. L'Herb. Boissier* 4: 6. 1900. Sacc. Syll. Fung. 16: 1015. 1902.

Pustules largely epiphyllous, punctiform, erumpent and surrounded by torn shreds of the epidermis, circinate, scattered, 100–150  $\mu$  in diameter, seated on brown spots, 2–5 mm. in diameter, and dead marginal areas of irregular shapes.

Conidia 5 celled, oblong-elliptic, 20–25  $\mu$ ; median cells umber or olivaceous, equally colored, guttulate, 14–17  $\times$  7–8.5  $\mu$ ; setae 2 or 3, usually 3, divergent, 18–24  $\mu$ ; basal cell obtuse; apical cell conic; pedicel short, erect, about 5  $\mu$ .

On living or wilting leaves of *Lespedeza bicolor* Turcz., Botanic Garden, Tokio, Japan, 1898, Kusano, in Herb. Sydow, Mus. Bot. Stockholm, Sweden.

49. *PESTALOTIA LONGISETA* Speg. *Michelia* 1: 478. 1879. Sacc. Syll. Fung. 3: 787. 1885.

Pustules sparse, epiphyllous, punctiform, lenticular or sub-spherical, black, 100–200  $\mu$  in diameter, seated on reddish or brown spots not exceeding .5 cm. in diameter, surrounded by a purple or black margin.

Conidia erect or curved, fusiform, hardly constricted at the septa, 22–25  $\mu$ ; colored cells 13–18  $\times$  7.6–8.6  $\mu$ , guttulate, the 2 upper umber, the lowest olivaceous; end cells hyaline, prominent, the apical cell conic, bearing 3 or rarely 4 coarse and widely

divergent setae, 18–38  $\mu$ ; basal cell conic, abruptly contracted into a narrow pedicel 4–11  $\mu$  (FIG. 1, 8).

On living leaves of *Rubus caesius* L., Susegana, Conegliano, Italy, Nov. 1876, Spegazzini.

According to Spegazzini the type occurs on *Rubus caesius* L. The collection studied bears the date and locality of the type but the host given is *R. fructicola*, an error. The fungus agrees in every respect with the original description and is regarded as the type. The long setae are characteristic of this species.

50. **Pestalotia macrochaeta** (Speg.) Guba, comb. nov.

*P. funerea* Desm. var. *macrochaeta* Speg. Anal. Mus. Nac. Buenos Aires III. 13: 412. 1911. Sacc. Syll. Fung. 22: 1226. 1913.

Pustules scattered, 100–200  $\mu$  in diameter, lenticular, erumpent, the sooty contents spread over the matrix.

Conidia elliptic-fusoid, usually erect, slightly constricted at septa, 16–20  $\mu$ ; median cells guttulate, olivaceous, equally colored, 11–14  $\times$  5–6  $\mu$ ; basal cell broad conic, abruptly obtuse; apical cell short conic or cylindric, bearing 3 setae, 8–14  $\mu$ , divergent; pedicel 2–7  $\mu$  (FIG. 2, 15).

On fallen needles of *Pinus sylvestris* L., Villa Elisa, Argentina, Aug. 1908, Spegazzini.

The needles are sparsely dotted with black pustules. The fungus shows no affinity to *P. funerea* Desm., therefore, should be renamed. According to Spegazzini, the setae are 30  $\mu$  long, whence the name, but study shows that the setae usually do not exceed 16  $\mu$  in length.

51. **PESTALOTIA MACROSPORA** Cesati, in Fres. Beit. Myk. 54–56. 1852; Klotzsch, Herb. Myc. Fung. 17: 1663. 1852. nomen nudum; Sacc. Syll. Fung. 3: 796. 1885. Klebahn, Myc. Centralbl. 4: 3. 1914.

*P. Pteridis* Sacc. in Thümen, Myc. Univ. 83. 1875; Sacc. Syll. Fung. 15: 242. 1901.

*P. funerea* Desm. var. *typica* Sacc. Michelia I: 479. 1879. Sacc. Syll. Fung. 3: 791. 1885.

Pustules globose-lenticular, mostly epiphyllous, sparse or crowded, sometimes coalescing, subepidermal, erumpent on maturity, darkening the substratum, 140–275  $\mu$  in diameter.



Conidia 5 celled, erect, long clavate,  $30-40 \times 7-9 \mu$ ; median colored cells  $20-29 \mu$ , cylindric, olivaceous, equally colored or slightly contrasted; apical hyaline cell small, obtuse, bearing a crest of 3-5, or usually 4-5 setae arising separately or in pairs and often branched,  $15-22 \mu$ ; basal hyaline cell long, acute, tapering into a rather long pedicel,  $6-11 \mu$  (FIG. 2, 9).

On blighted fronds of *Pteris aquilina* L. Fungus is characterized by long clavate spores, small apical cell and crest of numerous simple or branched setae.

Specimens examined: Klotsch, Herb. Myc. Fung. 17: 1663, 1852, Cesati; D. Saccardo, Myc. Ital. 1175, Monte'lo near Treviso, Italy, Sept. 1902; P. Sacc. Myc. Veneta 326, Montello, Italy; Petrak, F. Albanici et Bosniaci Ex. 33, Sept. 29, 1918, F. Petrak; Rabenhorst, Herb. Myc. 66 and Ex. Herb. Thümen and Thümen, Myc. Univ. 83, Montello, Italy, Sept. 1874, P. Saccardo, sub *P. Pteridis* Sacc.; Herb. Patouillard, Harvard University, Honnet, France, Trabut, sub *P. funerea* Desm. var. *typica* Sacc.

Accurate illustrations of this species were prepared by Voglino (Atti. Soc. Veneto-Trent. Sci. Nat. Padova 9: pl. 4, fig. 22, 1885), Saccardo (Fung. italici autographie delineati, Patavia, 1876-1886, Table 1114) and Klebahn (Myc. Centralbl. 4: 1914, fig. 34). Saccardo (Michelia 1: 479. 1879) reported *P. funerea* Desm. var. *typica* Sacc. on *Pteris aquilina* L., *Photinia serrulata* Lindl., *Eucalyptus Stewenianus*, *Rubus fruticosus* L., *Euonymus chinensis* Lindl., *Thuja* and *Cupressus* but Saccardo's assertion of such wide host range is incorrect.

## 52. *Pestalotia maculiformans* Guba & Zeller, sp. nov.

Acervuli punctiformes, epiphylli, innato-erumpentes,  $175-300 \mu$  diam., in maculis rotundis  $1.5-5$  mm. diam., "wood brown" vel cinereo-canis et purpureo-vel rubro-brunneis praetextis; conidiis fusoides, rectis, 5-cellularibus,  $22-28 \times 7-9 \mu$ , leniter ad septa constrictis; loculis 3 mediis guttulatis, infimis olivaceis, 2 superioribus obscurioribus,  $15-18 \mu$ , cellulis extremis prominentibus, infera turbinata, supera cylindracea in cilia 3, raro 2-4, abeunte, ciliis inaequalibus,  $9-20 \mu$  longis; conidiophoris rectis,  $3-7 \mu$  longis.

Acervuli epiphyllous, punctiform, subepidermal, becoming erumpent by an asteroid rupture of the epidermis,  $175-300 \mu$  in diameter, sooty from discharged spores at maturity, seated on

circular spots 1.5–5 mm. in diameter, wood brown to ashen grey on upper surface, with purplish or reddish brown border, almost concolorous below (FIG. 4).

Conidia fusoid, erect, 5 celled,  $22\text{--}28 \times 7\text{--}9 \mu$ , slightly constricted at the septa; three central cells guttulate, the lowest olivaceous, the two upper darker,  $15\text{--}18 \mu$ ; terminal cells prominent, the basal conic, the apical cylindric with 3, rarely 2 or 4 setae, irregular in length,  $9\text{--}20 \mu$ ; pedicel erect,  $3\text{--}7 \mu$ .

Associated with distinct, circular spots on living leaves of *Vaccinium ovatum* Pursh west of the Coast Range in Oregon, U. S. A.

*P. maculiformans* Guba & Zeller differs from *P. Vaccinii* (Shear) Guba in having broader conidia, shorter setae, and epiphyllous fruiting bodies. *P. Vaccinii* (Shear) Guba is not associated with leaf spots but completely covers the dead leaves. The illustration is taken from the type.

Specimens examined: Several collections from different locations near Waldport, Lincoln County, Oregon, S. M. Zeller, August 15 and October, 1929, in Herb. Oregon Agr. Coll., 4879 type, etc.; in Herb. Zeller, 7565 type, etc.; in Herb. Guba, 7565 type, etc.

### 53. *Pestalotia Micheneri* Guba, sp. nov.

*P. Araucariae* Berk. & Curt., nomen nudum, in Herb. Michener 19: 81. 2517, Mycology and Disease Survey, U. S. D. A.

Acervuli gregarii, nonnunquam coalescentes, amphigeni, globoso-lenticulari, innati deinde linis erumpentes,  $160\text{--}240 \times 80\text{--}160 \mu$ ; conidiis 5-cellularibus, rectis vel curvatis, anguste fusoides vel clavatis, utrinque fastigatis,  $19\text{--}23 \mu$ , vix ad septa constrictis, loculis mediis dilute olivaceis, guttulatis,  $13\text{--}15 \times 5\text{--}7 \mu$ , cellulis extremis longe turbinatis, supera angusta, triciliata, ciliis inaequalibus,  $4\text{--}12 \mu$  longis, infera longa acuta; conidiophoris rectis,  $3\text{--}5 \mu$  longis.

Fruiting pustules gregarious, sometimes coalescing, amphigenous, globose-lenticular, subepidermal, erumpent in a linear manner and surrounded by the torn epidermis,  $160\text{--}240 \times 80\text{--}160 \mu$ , densely distributed over the entire leaf surface.

Conidia 5 celled, erect or curved, narrow fusoid or clavate, tapering at both ends,  $19\text{--}23 \mu$ , hardly constricted at the septa; median cells dilute olivaceous and equally colored, prominently

guttulate,  $13-15 \times 5-7 \mu$ ; end cells long conic, tapering, the apical cell narrow with a crest of 3 erect setae of unequal length,  $4-12 \mu$ , the basal cell long, acute; pedicel erect,  $3-5 \mu$  (FIG. 2, 11).

On leaves of *Araucaria imbricata* Pav. (= *A. araucana* Koch.), North Garden, Chester Co., Pennsylvania, 1885.

Specimens examined: Michener (Herb. Michener 19: 81. 2517), United States Dept. Agr. sub *P. Guepini* Desm. and sub *P. Araucariae* Berk. & Curt., and in Herb. Curtis, Harvard University, sub *P. Guepini* Desm.

According to data accompanying the specimen in the Curtis Herbarium, Curtis received material as 2517 from Michener and assigned it the name *P. Araucariae* Berk. & Curt. Curtis sent material to Berkeley as 5564 and the latter changed the name to *P. Guepini* Desm. This conclusion is entertained because the original name *P. Araucariae* Berk. & Curt., still legible on the packet in the Curtis collection, was erased and *P. Guepini* Desm. written over it while the Michener collection bears both names, *P. Guepini* Desm. being written above *P. Araucariae* Berk. & Curt.

This species is characterized by narrow fusoid conidia, 3 short, erect setae and dilute olivaceous colored cells.

54. *PESTALOTIA MICROSPORA* Speg. Anal. Soc. Ci. Argent. 10: 31-32. 1880. Sacc. Syll. Fung. 3: 789. 1885.

Pustules conic, hemispherical, amphigenous, loosely gregarious, dense in places, rarely confluent, erumpent,  $72-150 \mu$  in diameter.

Conidia 5 celled, narrow fusoid, tapering to the base, erect or sometimes slightly curved, hardly constricted at septa,  $19-23 \mu$ ; median cells olivaceous, equally colored, guttulate,  $13-15 \times 5-7 \mu$ ; apical hyaline cell short, conic or cylindric, bearing a crest of 3 straight setae,  $6-14 \mu$ ; basal hyaline cell long, tapering; pedicel  $4-5 \mu$  (FIG. 1, 4).

On pale or brown weathered leaves of *Hedera Helix* L., Botanic Garden, College of Argentina, Buenos Aires, Apr. 1880, Spegazzini.

55. *PESTALOTIA MONTELLICA* Sacc. & Vogl. Atti. Soc. Veneto-Trentina Sci. Nat. Padova 9: 215-216. 1885. Sacc. Syll. Fung. 10: 489. 1892.

*P. Lucae* Savelli, Bull. Soc. Bot. Ital. 6-7: 62-68. 1917.

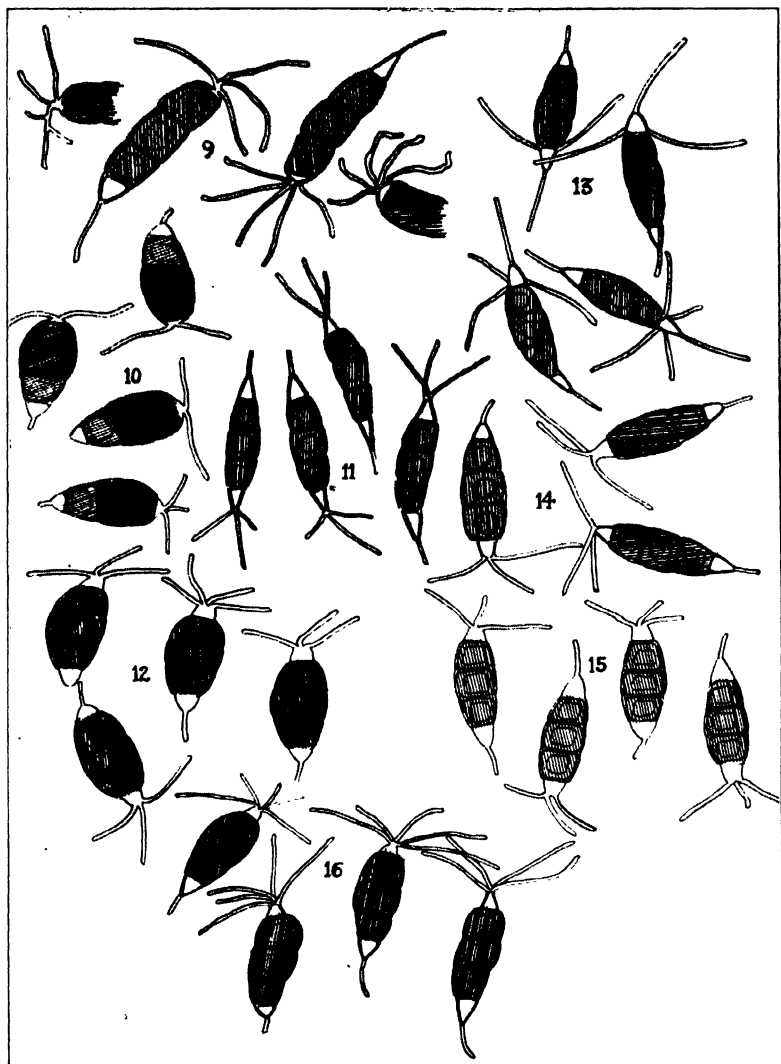


FIG. 2. Conidia: 9, *P. macrospora* Cesati from fronds of *Pteris aquilina* L., Montello, Italy, Sept. 1874, Saccardo, Ex Herb. Thümen; 10, *P. Myricae* Ellis & Martin from leaves of *Myrica cerifera* L., Green Cove Springs, Florida, Dec. 1882, G. Martin, Ellis, N. Am. Fungi 1222; 11, *P. Micheneri* Guba from leaves of *Araucaria imbricata* Pav., Chester County, Pennsylvania, 1885, Michener, Herb. Michener 2517; 12, *P. pampeana* Speg. from twigs of *Discaria americana* Gill & Hook., Cordova, Argentina, April 1905, Spegazzini; 13, *P. montellica* Sacc. & Vogl. from leaves of *Quercus tinctoria* Bartr., West Chester, Pennsylvania, B. M. Everhart, Ellis & Ev. Fungi Columb. 1352; 14, *P. neglecta* Thümen from leaves of *Euonymus japonicus* L., Conegliano, Italy, Oct. 1876, Spegazzini, Thümen, Myc. Univ. 884; 15, *P. macrochaeta* (Speg.) Guba from needles of *Pinus sylvestris* L., Villa Elisa, Argentina, Aug. 1908, Spegazzini; 16, *P. polychaeta* Cooke & Hark. from twigs of *Cytisus* sp., California, Herb. Roy. Bot. Gard., Kew 2095.  $\times 750$ .

Pustules subglobose, punctiform, amphigenous, distinct or dense in places, circular, 120–175  $\mu$  in diameter, seated generally over the surface.

Conidia 5 celled, erect, fusiform, 21–26  $\mu$ ; median cells olivaceous, equally colored, not constricted at septa, 15–17  $\times$  6–7  $\mu$ ; end cells narrow, tapering, the apical cell beaked with one vertical bristle and usually 3, sometimes 2 reflexed bristles arising from the base of the apical cell, 12–17  $\mu$ ; pedicel erect, 4–9  $\mu$  (FIG. 2, 13).

On leaves of *Quercus tinctoria* Bartr. (= *Q. velutina* Lam.) in Ellis & Ev. Fungi Columb. 1352, West Chester, Penna., B. M. Everhart sub *P. stellata* Berk. & Curt.

The presence of 3 setae around the base of the apical cell and one at the apex is characteristic of this species. Contrary to the opinion of Cooke and Ellis (Grevillea 6: 85. 1878) this fungus is not identical with *P. stellata* Berk. & Curt., which occurs on leaves of *Ilex opaca*. The specimen on leaves of *Quercus velutina* Lam. agrees in every respect with *P. montellica* Sacc. & Vogl., the type of which was described on leaves of *Quercus* sp. collected in the forests of Montello in northern Italy by P. Saccardo.

Savelli (l.c.) created the species *P. Lucae* Sav. on leaves of *Quercus ilex* L. var. *agrifolia*, which according to his description differs from *P. montellica* Sacc. & Vogl. in that the conidia measure 28–29  $\times$  10–11  $\mu$  and the setae number 3 of which 1 is terminal and 2 are reflected from the base of the apical cell. Another distinction which Savelli offers to support the individuality of *P. Lucae* Savelli is its association with leaf spots while *P. montellica* Sacc. & Vogl. is not so associated. *P. Lucae* Savelli is regarded as a synonym.

56. PESTALOTIA MYRICAE Ellis & Martin, Am. Nat. 18: 70. 1884. Sacc. Syll. Fung. 3: 785. 1885.

Pustules minute, sparse, amphigenous, innate-erumpent, circular, 50–100  $\mu$ , limited to dead, irregularly shaped, discolored areas.

Conidia broad-elliptic or ovoid, 5 celled, erect, hardly constricted at the septa, 17–20  $\mu$ ; upper two colored cells umber, the lowest olivaceous, 12–16  $\times$  7–9  $\mu$ ; end cells hyaline, the basal broad conic, abruptly contracted into a short pedicel, 2–5  $\mu$ ; apical cell short, often indistinct, bearing at its extremity 2, sometimes 3 usually straight and oppositely divergent setae, 8–14  $\mu$  (FIG. 2, 10).

On partly fresh leaves of *Myrica cerifera* L. in Ellis, N. Am. Fungi 1222, Green Cove Springs, Florida, Dec. 1882, G. Martin.

The original description of this fungus is unsatisfactory. The conidia are wrongly described with 2 septa and their dimensions are inaccurately stated.

57. PESTALOTIA NEGLECTA Thümen, Inst. Rev. Sci. Coimbra II. 27: 326. 1880. Sacc. Syll. Fung. 3: 788. 1885.

*P. funerea* Desm. var. *Euonymi-japonici* Thümen, Myc. Univ. 884, 1887, nomen nudum.

Pustules amphigenous, usually epiphyllous, numerous, densely gregarious in places, coalescing but usually free, globose-conic, subepidermal, raising the epidermis then surrounded by its torn shreds, exposing the sooty contents, usually 100–150  $\mu$  in diameter, generally distributed and at maturity blackening the matrix.

Conidia 5 celled, narrow fusiform, erect or often curved, tapering to a point at the base, usually 20–26  $\mu$ , slightly constricted at the septa; median colored cells pale olivaceous, guttulate, 13–16  $\times$  5–7  $\mu$ , the two upper colored cells often darker than the lower; apical hyaline cell long cylindric or conic, bearing a crest of 3 setae, 9–23  $\mu$ , usually less than 20  $\mu$  and curved; basal hyaline cell long, attenuated into an erect pedicel, 3–7  $\mu$  (FIG. 2, 14).

On dead brown or somewhat green leaves of *Euonymus japonicus* L. associated with other fungi.

Specimens examined: Thümen, Myc. Univ. 884, Venetia, Conegliano, Italy, October 1876, Spegazzini, sub *P. funerea* var *Euonymi-japonici* Thümen; Contr. Myc. Lusit. 343 (Ser. II) in Herb. Jard. Bot. Univers. Coimbra, Portugal, 275, Zombaria, Portugal, Jan. 1879, A. Moller; Herb. A. B. Langlois 17: 11, 86 sub *P. Euonymi* Vize; Office Foreign Plant Quar. and Insp. U. S. D. A., Society Hill, So. Carolina, Oct. 30, 1916, J. T. Rogers.

This species is characterized by narrow pointed conidia crested with 3 setae. The fruiting pustules are densely arranged on either surface of the browned leaves. The type collected by Spegazzini at Conegliano, Italy, and named *P. funerea* Desm. var. *Euonymi-japonici* Thümen but not described is wholly unlike *P. funerea* Desm. A later collection by Moller at Zombaria, Portugal, also submitted to Thümen for identification was described with the name *P. neglecta* Thümen. The two

specimens are identical and since this species is distinct from all others the name *P. neglecta* Thümen is retained.

Klebahn (Myc. Centralbl. 4: 10-11. 1914) wrongly included *P. funerea* Desm. var. *Euonymi-japonici* Thümen (= *P. neglecta* Thümen) in his concept of *P. gracilis* Klebahn. The latter name was also applied to several different species of *Pestalotia* of which the first listed occurs on *Laurus Sassafras* (= *Sassafras varifolium* (Salisb.) Ktze.) in Ellis & Ev. Fungi Columb. 370b sub *P. Guepini* Desm. and which is the type of *P. gracilis* Klebahn according to Guba (Phytopathology 19: 217. 1929).

58. *PESTALOTIA OXYANTHI* Thümen, Inst. Rev. Sci. Coimbra 28: 420. ~1880. Sacc. Syll. Fung. 3: 790. 1884.

Acervuli largely hypophyllous, numerous, punctiform, hemispherical or applanate, subepidermal, erumpent and surrounded by the torn epidermis, the flat circular outline of the pustule exposed to view, generally distributed, 150-225  $\mu$  in diameter.

Conidia 5 celled, long and narrow clavate, tapering toward the ends, erect or curved, 24-29  $\mu$ , median cells 16-19  $\times$  6-7  $\mu$ , guttulate, the upper two cells umber, the lowest olivaceous, only slightly constricted at the septa; apical hyaline cell long, narrow, cylindric or conic, the basal cell long, tapering, acute; setae usually 3, rarely 2 or 4, flexuous, 13-30  $\mu$ ; pedicel short, erect, 3-10  $\mu$ .

On dead leaves of *Oxyanthus pubescens* in greenhouse, Botanic Garden, Coimbra, Portugal, August, 1879, A. Moller 641 and Contr. Myc. Lusit. 574 (Ser. III) in Herb. Jard. Bot. Univers. Coimbra.

59. *PESTALOTIA PAMPEANA* Speg. Anal. Mus. Nac. Buenos Aires III. 13: 412. 1911. Sacc. Syll. Fung. 22: 1220. 1913.

Acervuli black, sparse, innate in the cortex, later erumpent, circular, subglobose, 75-225  $\mu$  in diameter, on pale spots girdling the twigs with distinct brown margins.

Conidia 5 celled, broad elliptic to ovoid, erect, 17.5-20  $\mu$ , often strongly constricted at the middle septa; median cells thick walled, cask shaped, short, umber or fuliginous, equally colored, 11-13.5  $\times$  7.7-9  $\mu$ ; apical cell short conic, usually small, bearing a crest of 3, or rarely 4 erect setae, 6-11  $\mu$ ; basal cell small, short conic, abruptly contracted into an erect pedicel, 4-7  $\mu$  (FIG. 2, 12).

On living twigs of *Discaria americana* Gill & Hook., Cordova, Argentina, April 1905, Spegazzini.

The original description is not adapted to the type specimens. Illustrations of the conidia deposited with the type material show long, flexuous pedicels and long setae. My study reveals short pedicels and short setae and 4 rather than 3 septate conidia.

60. PESTALOTIA PEREGRINA Ellis & Martin, Jour. Myc. 1: 100.

1885. Sacc. Syll. Fung. 10: 490. 1892.

Pustules amphigenous, lenticular or elongate-elliptic, scattered but frequently confluent, covered at first, later erumpent, raised and effuse, blackening the matrix,  $80-120 \times 50-70 \mu$ .

Conidia oblong-elliptic or obovate, 5 celled,  $21-24 \mu$ , hardly constricted at the septa; median cells guttulate, olivaceous, equally colored,  $13-17 \times 6-8 \mu$ ; hyaline end cells short, subconical, prominent, crest of 3 divergent setae,  $8-17 \mu$  or about equal to the length of the colored cells; pedicel erect,  $6-9 \mu$ .

On dead leaves of cut-off branches of *Pinus austriaca* Link (= *P. Laricio* Poir.), Newfield, N. J., May 1885, in Ellis & Ev. N. Am. Fungi 2nd Ser. 1627.

61. PESTALOTIA PLANIMI Vize, Grevillea 5: 109. 1877. Sacc.

Syll. Fung. 3: 788. 1885.

*P. Euonymi* Vize, Bull. Calif. Acad. Sci. 2: 161. 1885.

Sacc. Syll. Fung. 15: 242. 1901.

*P. spectabilis* Klebahn, Myc. Centralbl. 4: 3. 1914.

Pustules amphigenous, subglobose, numerous, gregarious, coalescing freely, subepidermal, then erumpent, rupturing epidermis in radiating manner, black sooty contents spreading over the matrix,  $175-350 \mu$  in diameter, generally distributed.

Conidia 5 celled, long fusiform, tapering to the base, erect, slightly constricted at the septa,  $29-37 \mu$ ; median cells guttulate, the upper two umber, cylindric, the lowest olivaceous, conic,  $20-26 \times 8-10 \mu$ ; end cells hyaline, large, the apical cell long cylindric, bearing a crest of 3 or sometimes 2 long curved setae,  $20-40 \mu$ , the basal cell long, tapering into a slender pedicel,  $6-11 \mu$  (FIG. 3, 17).

On dead weathered leaves of *Euonymus japonicus* L., associated with other fungi. Black sooty masses of spores stand out in striking contrast to the pale brown colored matrix.

Specimens examined: Ellis, N. Am. Fungi 758, San Francisco,



California, 1881, H. W. Harkness; Thümen, Myc. Univ. 2085, Ibid., sub *P. Planimi* Vize var. *Euonymi-japonici* Thümen; Dept. Plant Path. N. Y. State Coll. Agr. 6762, California, G. F. Meschutt; Thümen, Myc. Univ. 884b, Coimbra, Portugal,

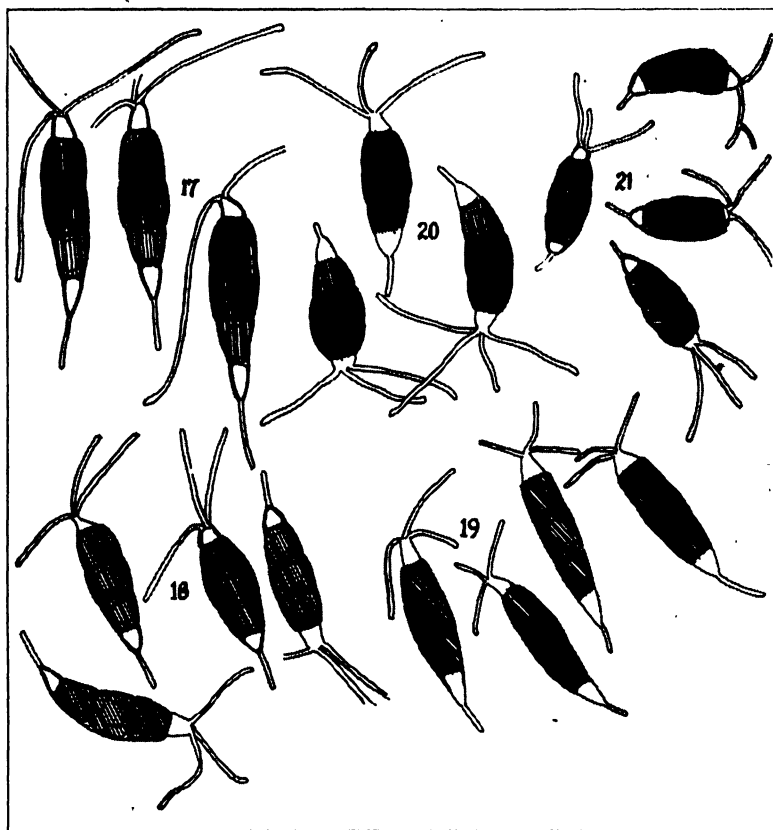


FIG. 3. Conidia: 17, *P. Planimi* Vize from leaves of *Euonymus japonicus* L., San Francisco, Calif., 1881, Harkness, Ellis, N. Am. Fungi 758; 18, *P. quercina* Guba from leaves of *Quercus tinctoria* Bartr., Ellis, N. Am. Fungi 34; 19, *P. Royenae* Guba from leaves of *Royena lucida* L., Padua, Italy, Nov. 1897, in D. Sacc. Myc. Ital. 182; 20, *P. scirpina* Ellis & Martin from culms of *Scirpus palustris* L., Palermo, Argentina, May 1881, Spegazzini; 21, *P. vaccinicola* Guba from leaves of *Vaccinium arboreum* March, Green Cove Springs, Florida, G. Martin, Ellis & Ev. Fungi Columb. 1352.  $\times 750$ .

Jan. 1879, A. Moller, sub *P. funerea* Desm. var. *Euonymi-japonici* Thümen.

The conidia of this species are unusually large. The fungus

was named *P. Planimi* Vize and wrongly reported on dead stems of *Planimus*. Harkness made known the error and stated that the name should be *P. Euonymi* Vize and the host *Euonymus japonicus* L. There is, however, no rule which would permit this change. Therefore, the original name, although inconsistent, must be retained.

Klebahn (Myc. Centralbl. 4: 3. 1914) made a new species, *P. spectabilis* Kleb., of the specimen in Thümen, Myc. Univ. 884b sub *P. funerea* Desm. var. *Euonymi-japonici* Thümen, but my study of this fungus shows that it is identical with *P. Planimi* Vize.

62. PESTALOTIA POLYCHAETIA Cooke & Hark. Grevillea 12: 94. 1884. Sacc. Syll. Fung. 3: 785. 1885.

Pustules black, subglobose, scattered, subepidermal, covered at length, then erumpent, tearing epidermis in stellate manner and surrounded by the torn epidermis, 250–290  $\mu$  in diameter.

Conidia 5 celled, usually erect, broad clavate, only slightly constricted at septa, 26–29  $\mu$ ; median cells guttulate, umber, 17.5–20  $\times$  8.4–9.4  $\mu$ ; apical cell cylindric or long conic; basal cell long conic, tapering; setae 4–6, usually 5, 9–25  $\mu$ ; pedicel erect, 4–9.8  $\mu$  (FIG. 2, 16).

On twigs of *Cytisus* sp., California, in Herb. Roy. Bot. Gard., Kew, 2095.

The type description which is in error mentions 3 celled spores and otherwise is lacking in details necessary to a good understanding of the species.

63. PESTALOTIA PSIDII Pat. Bull. Soc. Myc. Fr. 8: 136. 1892, nomen nudum. Bull. Soc. Myc. Fr. 11: 232. 1895. Sacc. Syll. Fung. 14: 1025. 1899.

Pustules gregarious, lenticular or subglobose, innate-erumpent, tearing the epidermis in a circinate manner, 100–200  $\mu$  wide.

Conidia 5 celled, oblong-clavate or elliptic-fusoid, erect, hardly constricted at the septa, 21–25  $\mu$ ; median colored cells guttulate, olivaceous, the two upper slightly darker than the lowest, 15–18  $\times$  6–8  $\mu$ ; end cells hyaline, the apical cell conic or cylindric, crowned with 3 setae, the basal cell obtuse; pedicel 3–5  $\mu$ , erect.

On fruits of *Psidium pomiferum* L. (= *P. Guajava* L.), Ecuador, Sept. 1891, G. de Lagerheim.

64. *PESTALOTIA QUADRICILIATA* Bub. & Dearn. *Hedwigia* 58: 31. 1916.

Pustules subglobose to lenticular, epiphyllous, immersed and covered by the epidermis, 90–175  $\mu$  wide, sparse, seated on circular brown spots not exceeding .8 cm. in diameter.

Conidia elliptic-fusoid or broad clavate, 5 celled, 21–26  $\mu$ , erect; median cells olivaceous or umber, equally colored, 15–18  $\times$  8–10  $\mu$ , slightly constricted at the septa; apical cell conic, crowned with 4 slender setae, 9–17  $\mu$ ; basal cell obtuse or rounded, seated on a short pedicel, 2–5  $\mu$ .

On partly green leaves of *Vitis vulpina* Bartram (= *V. labrusca* L.), London, Canada, October 9, 1910, J. Dearness. The fungus is secondary and the spots are apparently due to a *Phyllosticta* which is present in greater abundance.

65. *Pestalotia quercina* Guba, sp. nov.

Acervuli amphigeni, innato-erumpentes, 80–150  $\mu$  in diam., fumosi, conidiis fusoidis vel clavatis rectis 5 cellularibus, 19–25  $\times$  6–7  $\mu$ , leniter ad septa constrictis; loculis 3 mediis guttulatis, olivaceis, 13–16  $\mu$ ; cellulis extremis prominentibus, hyalinis, apicalibus late-cylindraceutis, triciliatis, ciliis raro ramosis, 11–19  $\mu$  longis; conidiophoris rectis, 6–9  $\mu$  longis.

Acervuli amphigenous, innate-erumpent, numerous, scattered or gregarious, circular, 80–150  $\mu$  in diameter, sooty at maturity.

Conidia 5 celled, fusoid-clavate, tapering to the base, erect, hardly constricted at the septa, 19–25  $\times$  6–7  $\mu$ ; median cells guttulate, olivaceous, equally colored, 13–16  $\mu$ ; exterior cells hyaline, prominent; apical cell frequently broad cylindric with a crest of 3 setae, 11–19  $\mu$ , rarely branched; pedicel erect, 6–9  $\mu$  (FIG. 3, 18).

On dead weathered leaves of *Quercus tinctoria* Bartr. (= *Q. velutina* Lam.) associated with *Discosia* sp.

Specimens examined: Ellis, N. Am. Fungi 34 sub *P. stellata* Berk. & Curt.; on *Quercus* sp., Arlington, Va., March 31, 1929, C. L. Shear, 5785. The fungus shows no similarity to *P. stellata* Berk. & Curt. on leaves of *Ilex opaca* Ait. or to *P. monticola* Sacc. & Vogl. on leaves of *Quercus*.

66. *Pestalotia Royenae* Guba, sp. nov.

*P. funerea* Desm. var. *Royenae* D. Sacc. Myc. Ital. 2: 182. 1898, nomen nudum.

Acervuli hypophylli, globoso-lenticulares, numerosi generaliter distributi et saepe gregarii, erumpentes, prominentes, 50–160  $\mu$  diam.; conidiis 5 cellularibus, rectis, vel nonnunquam leniter curvatis, vix ad septa constrictis, 22–25  $\mu$ , loculis mediis olivaceis aequaliter coloratis vel 2 superioribus leviter obscurioribus, guttulatis, 15–17  $\times$  5–7  $\mu$ ; cellulis extremis prominentibus, infera acute fastigata in pedicillum filiforme conidium separans, supera cylindracea triciliata, ciliis rectis brevibus, 4–11  $\mu$  longis; conidio-phoris 2–7  $\mu$  longis.

Pustules hypophyllous, globose-lenticular, numerous, generally distributed and gregarious in places, erumpent on maturity, protruding and surrounded by the torn epidermis, the contents sooty and spreading, 50–160  $\mu$  in diameter.

Conidia 5 celled, erect or sometimes slightly curved, long fusoid, tapering to the base, hardly constricted at the septa, 22–25  $\mu$ ; median cells olivaceous, equally colored or the two upper somewhat darker, guttulate, 15–17  $\times$  5–7  $\mu$ ; setae 3, short, straight, 4–11  $\mu$ ; apical cell cylindric, basal acute, tapering into a short stalk, 2–7  $\mu$  (FIG. 3, 19).

On weathered leaves of *Royena lucida* L., Botanic Garden, Padua, Italy, Nov. 1897.

In D. Saccardo Myc. Ital. 182 reference is made apparently to a description of this species in Sacc. Syll. Fung. 3: 791. 1885, but the reference is in error and no earlier publication of *P. funerea* Desm. var. *Royenae* D. Sacc. can be found.

67. *PESTALOTIA SCIRROFACIENS* Brown, Phytopathology 10: 383–393. 1920.

Pustules immersed, later erumpent, covered with an irregular layer of thickened bark.

Conidia ovate-oblong to spindle shape, 5 celled, slightly curved, 22–29  $\times$  7–10  $\mu$ ; lowest colored cell olivaceous, the two above umber or fuliginous, 14–19  $\mu$ , with slight or no constriction at the septa; setae 3, rarely 4, bent at right angles to the spore, 9–23  $\mu$ ; end cells conic, the basal sometimes tapering; pedicel short, erect, 3–6  $\mu$ .

On bark of *Sapota Achras* Mill., associated with hard woody galls or tumors partly covered with lichens, algae and other fungi, Buena Vista, Florida, P. H. Rolfs.

Study was confined to a culture received from Miss Nellie Brown. Host tissue bearing the fungus was not available but Brown (l.c.) has supplied the spore measurements on different media as follows:

On <i>Sapota Achras</i> Mill. ....	16-24 × 6-10 $\mu$
On potato pieces .....	20-26 × 5-6 $\mu$
On corn meal agar .....	16-30 × 6-8 $\mu$

Doyer (Meded. Phytopath. Lab. "Willie Comm. Scholt" 9: 1-72. 1925) found that the 3 middle cells ranged in length mostly from 15-18.5  $\mu$ .

Brown regarded this species as the cause of tumors on stems of the sapodilla tree and her contention is supported by artificial production of the disease. Older tissue was especially susceptible. Leaves of sapodilla inoculated with the sapodilla-tumor *Pestalotia* produced reddish well defined spots and the conidia recovered from these spots maintained the typical characteristics of those produced in the tumor. She also produced by artificial methods of inoculation tumors on mango (*Mangifera indica* L.), olive (*Olea europaea* L.) and balsam (*Abies balsamea* Mill.) and the fungus was again recovered from these tumors. On larch (*Larix occidentalis* Nutt.), blue spruce (*Picea pungens* Engelm.) and hemlock (*Tsuga canadensis* Carr.) the fungus produced a blight instead of outgrowths. Wounding was unnecessary for infection but helped to increase it.

Doyer, using Brown's original culture of *P. scirrofaciens* Brown, was unable to produce galls or blight after a long series of attempts and consequently denied the infectious nature of this species. Further biologic studies are desirable in view of the fact that the results of more recent investigations dealing with the biology of species of *Pestalotia* show definitely the innocuous nature of the species to healthy tissue.

Doyer believed that *P. scirrofaciens* Brown is the same as *P. versicolor* Speg. The writer's study of both forms indicates a very close relationship.

68. *PESTALOTIA SORBI* Pat. Rev. Myc. 8: 182. 1886. Sacc. Syll. Fung. 10: 486. 1892.

Pustules black, epiphyllous, sparse, punctiform, circular, on small brown orbicular spots less than 1 cm. in diameter.

Conidia elliptic-fusoid, 5 celled, erect, 16-18 × 5-7  $\mu$ , constricted at the septa; median cells umber, equally colored, 11-13  $\mu$ ; setae 2 or rarely 3, divergent, 8-11  $\mu$ ; basal cell obtuse, apical cell short cylindric; pedicel 1-4  $\mu$ , short.

On leaves of *Sorbus* sp., Yunnan, China, 1887, Delavay, in Herb. Patouillard in Herb. Farlow, Harvard University.

69. *PESTALOTIA STICTICA* Berk. & Curt. *Grevillea* 2: 155. 1874.  
Sacc. Syll. Fung. 3: 793. 1885.

Pustules globose-lenticular, numerous, black, largely hypophyllous, scattered over the matrix, frequently coalescing, 50–125  $\mu$  in diameter.

Conidia 5 celled, elliptic-fusoid, 18–22  $\mu$ , somewhat swollen through the middle, usually erect; colored cells 12–15  $\times$  6–8  $\mu$ , guttulate, hardly constricted at the septa, upper two usually darker than the lowest; apical cell long conic, crested with 3 divergent setae, 7–16  $\mu$ ; basal cell obtuse, supported by an erect pedicel, 4–8  $\mu$ .

On brown fallen leaves of *Platanus occidentalis* L., Santee River, So. Carolina, Ravenel in Herb. Curtis 1638 at Harvard University and Herb. Berkeley in Herb. Roy. Bot. Gard., Kew.

The type description which is very vague also embraces fungus on leaves of *Tilia* sp. from Alabama (Beaumont, 4608) but this is a distinct species, *P. Tiliae* Guba. Since the type description of *P. stictica* Berk. & Curt. suggests application to the species on *Platanus* its restriction to that species is accepted.

70. *PESTALOTIA SYDOWIANA* Bresadola, *Hedwigia Beibl.* 35: 32–33. 1896. Sacc. & Sydow in Sacc. Syll. Fung. 14: 1027. 1899.

Acervuli globose-lenticular, epiphyllous, sparse or densely gregarious, erumpent and surrounded by the torn epidermis, 150–300  $\mu$  in diameter, on angular ash-gray or brown spots surrounded by a red margin.

Conidia 5 celled, erect, elliptic-fusoid, 24–28  $\mu$ ; median cells guttulate, olivaceous, the two upper darker than the lowest, 16–19  $\times$  8–9.5  $\mu$ , hardly constricted at the septa; apical hyaline cell long and broad cylindric; basal hyaline cell broad conic; setae 3, usually divergent or recurved, flexuous, 24–40  $\mu$ ; pedicel 6–12  $\mu$ .

On living leaves of *Gaultheria procumbens* L., Botanic Garden, Berlin, Germany, 1894–95, P. Sydow, in Sydow, Myc. Marth. 4372.

71. *Pestalotia Tiliae* Guba, sp. nov.

Acervuli amphigeni, gregarii vel remoti, innati deinde erumpentes, epidermide lacerata cincti, atri, effusi, 75–200  $\mu$  diam.,

in maculis brunneis; conidiis late fusoideis vel pyriformibus, plerumque inaequilateralibus, 24–29  $\mu$ , cellulis mediis coloratis 16–19  $\times$  9.5–11.5  $\mu$ , cellulis 2 superis fuliginis, opacis, subglobose vel inflatis, infimis “umber” forte ad septa constrictis, cellulis extremis prominentibus, infera longa turbinataque, supera hyalina brevi turbinata triciliata; ciliis crassis, 18–27  $\mu$ , divergentibus; conidiophoris 4–7  $\mu$  longis.

Pustules amphigenous, scattered or gregarious, subepidermal, erumpent on maturity, surrounded by the torn shreds of the epidermis, black, effuse, 75–200  $\mu$  in diameter, seated on large definite brown areas.

Conidia broad fusoid or pyriform, usually inequilateral, 24–29  $\mu$ ; median colored cells 16–19  $\times$  9.5–11.5  $\mu$ , the upper two colored cells fuliginous, opaque, subglobose or swollen, the lowest umber, strongly constricted at the dividing septum; apical hyaline cell short, conic, the basal usually long and tapering; setae 3, coarse, 18–27  $\mu$ , widely divergent; pedicel 4–7  $\mu$ .

On leaves of *Tilia* sp., Santee River, Alabama, in Herb. Curtis 4608 (Beaumont, 266) at Harvard University and Herb. Roy. Bot. Gard., Kew, sub *P. stictica* Berk. & Curt.

The type of *P. stictica* Berk. & Curt. was described on leaves of *Platanus occidentalis* L. and *Tilia* sp. The specimens on both hosts are distinct and since the characters of the form on *Platanus* agree best with the type description of *P. stictica* Berk. & Curt. the new name *P. Tiliae* Guba is assigned to the form on *Tilia*.

## 72. *Pestalotia vaccinicola* Guba, sp. nov.

Acervuli epiphilli, punctiformes, erumpentes, epidermide lacerata cincti, 45–90  $\mu$  diam. in maculis definitis rotundatis .5 cm. minoribus supra albidis, infra brunneis; conidiis elliptice-fusoideis, 5 cellularibus, rectis vel leniter curvatis, loculis mediis aequaliter coloratis, guttulatis, 10–13  $\times$  5–7  $\mu$ ; cellulis extremis breve turbinatis; ciliis saepe 3 raro 2, saepe ramosis divergentibusque, 4–11  $\mu$  longis; conidiophoris rectis, 2–5  $\mu$  longis.

Pustules epiphyllous, punctiform, subepidermal, erumpent at maturity and surrounded by the torn epidermis, 45–90  $\mu$  in diameter, seated in small definite circular spots not exceeding .5 cm. in diameter, pale whitish above and brown beneath.

Conidia elliptic-fusoid, 5 celled, 15–18  $\mu$ , erect or slightly curved; median cells dark olivaceous, equally colored, guttulate, 10–13  $\times$  5–7  $\mu$ ; end cells short conic; setae usually 3, sometimes 2, often branched, divergent, 4–11  $\mu$ ; pedicel erect, 2–5  $\mu$  (FIG. 3, 21).

On living leaves of *Vaccinium arboreum* Marsh., Green Cove Springs, Fla., G. Martin in Ellis & Ev. Fung. Columb. 1352 sub *P. stellata* Berk. & Curt.

The fungus is always associated with leaf spots. This exsiccati collection contains leaves of *Quercus tinctoria* Bartr. (= *Q. velutina* Lim.) and *Vaccinium arboreum* Marsh., each of which bears distinct types of *Pestalotia* and neither of which resembles *P. stellata* Berk. & Curt. The type on *Quercus* has been named *P. quercina* Guba.



FIG. 4. Leaf spots on *Vaccinium ovatum* Pursh., bearing *P. maculiformans* Guba & Zeller. Photo by S. M. Zeller.

73. *PESTALOTIA VERSICOLOR* Speg. var. *AMERICANA* Speg. Anal. Soc. Ci. Argent. 13: 21. 1882. Sacc. Syll. Fung. 3: 791. 1885. = *P. scirpina* Ellis & Martin, Am. Nat. 19: 76. 1885. Phytopathology 19: 208. 1929.

On fallen decaying culms of *Scirpus palustris* L. (= *Eleocharis palustris* R. Br.), Rio de la Plata, Palermo, Argentina, May 15, 1881, Spegazzini (FIG. 3, 20).



Saccardo (Syll. Fung. 15: 241. 1901) listed *P. americana* Speg. as a synonym of *P. versicolor* Speg. var. *americana* Speg., but I have been unable to find any mention of *P. americana* Speg. in Spegazzini's publications.

*P. americana* Montagne in Gay, Historia de Chile (Bot.) 7: 481. 1850 is *Monochaetia americana* (Mont.) Sacc. according to Saccardo (Syll. Fung. 18: 485. 1906).

#### KEY TO SPECIES IN PARTS I AND II

The usefulness of this key is limited to those species of *Pestalotia* reported in Parts I and II of this monograph. For Part I see Phytopathology 19: 191-232. 1929. In using this key mean dimensions and typical characters should be strongly emphasized. Aberrant characters should not be considered.

- a. Setae 2 or usually 2.
  - b. Conidia 16-18  $\mu$ .
    - c. Colored cells 10-13  $\times$  5-7  $\mu$ .
      - d. Setae 6-12  $\mu$ .
        - e. Colored cells pale olivaceous, equally colored..... *P. Aletridis*.
        - ee. Colored cells umber, equally colored.... *P. Sorbi*.
    - bb. Conidia 17-20  $\mu$ , broad elliptic or ovoid.
      - c. Colored cells 12-16  $\times$  7-9  $\mu$ .
        - d. Setae 2 or 3, 8-14  $\mu$ ..... *P. Myricae*.
    - bbb. Conidia 20-25  $\mu$ .
      - c. Colored cells 13-15  $\times$  5-7  $\mu$ .
        - d. Setae 6-14  $\mu$ .
          - e. Colored cells olivaceous, equally colored.
            - g. Pustules subglobose, 200-250  $\mu$ ... *P. dichaela*.
      - cc. Colored cells 15-17  $\times$  5-7  $\mu$ .
        - d. Setae 5-11  $\mu$ .
          - e. Upper 2 colored cells umber, the lowest olivaceous.
            - g. Pustules subglobose, 100-200  $\mu$ ... *P. copernica*.
  - aa. Setae 3 or usually 3.
    - b. Conidia 13-20  $\mu$ .
      - c. Colored cells 10-15  $\times$  4-6  $\mu$ .
        - d. Setae 8-16  $\mu$ , arising from different points on rounded apex.
          - e. Colored cells pale olivaceous, equally colored.
            - f. Conidia 18-23  $\mu$ : pustules 225-500  $\times$  100-200  $\mu$ ..... *P. unicolor*.
      - dd. Setae 8-14  $\mu$ , arising at apex of terminal cell.
        - e. Colored cells olivaceous, equally colored.
          - f. Conidia 16-20  $\mu$ : pustules 100-200  $\mu$  . *P. macrochaeta*.

- cc. Colored cells  $10-15 \times 5-7 \mu$ .
- d. Setae  $4-12 \mu$ .
- e. Colored cells olivaceous, equally colored.
- f. Conidia oblong or elliptic fusoid.
- g. Pustules  $45-90 \mu$ , subglobose. . . . . *P. vaccinicola*.
- gg. Pustules  $70-120 \mu$ .
- On leaves of *Prunus* . . . . . *P. adusta*.
- On needles of conifers . . . . . *P. Cryptomeriae*.
- ee. Upper 2 colored cells umber, lowest olivaceous.
- g. Pustules  $140-280 \mu$  in diam. . . . . *P. stellata*.
- dd. Setae  $7-17 \mu$ .
- e. Colored cells olivaceous, equally colored.
- f. Conidia elliptic fusoid, basal cell short obtuse.
- g. Pustules epiphyllous, scattered,  $75-125 \mu$ .
- Setae 3, simple . . . . . *P. pallidicolor*.
- gg. Pustules  $100-200 \mu$ ; on needles.
- Setae 3, simple . . . . . *P. macrochaeta*.
- ggg. Pustules  $90-175 \mu$ , amphigenous.
- Setae 3, often  $1-4$  and branched . . . . . *P. Guepini*.
- ff. Conidia clavate, basal cell tapering. . . . . *P. vermiformis*.
- ee. Upper 2 colored cells umber, lowest olivaceous.
- f. Conidia elliptic-fusoid, basal cell broad conic.
- g. Pustules  $100-200 \mu$ ; setae irregularly divergent; conidia erect. . . . . *P. gibberosa*.
- gg. Pustules  $170-400 \times 80-300 \mu$ ; setae disposed at right angles; conidia angulate . . . . . *P. palmarum*.
- eee. Upper 2 colored cells fuliginous, lowest olivaceous.
- f. Conidia elliptic-fusoid,  $18-22 \mu$ .
- g. Pustules  $50-140 \mu$  in diam. . . . . *P. stictica*.
- ddd. Setae  $16-25 \mu$ .
- e. Upper 2 colored cells fuliginous, lowest olivaceous.
- f. Conidia clavate-fusoid, tapering.
- g. Pustules globose-lenticular,  $75-200 \mu$  . . . . . *P. Menezesiana*.
- ccc. Colored cells  $10-15 \times 7-9 \mu$ .
- d. Setae  $4-11 \mu$ ; conidia elliptic or ovate-fusoid.
- e. Upper 2 colored cells umber, lowest olivaceous.
- g. Pustules  $140-280 \mu$ , subglobose. . . . . *P. stellata*.
- ee. Colored cells umber or slightly darker, equally colored.

- g. Pustules 75–225  $\mu$  in diam. . . . . *P. pampeana*.
- dd. Setae 7–16  $\mu$ .
- e. Upper 2 colored cells umber, lowest olivaceous.
- f. Conidia broad elliptic, 17–20  $\mu$ .
- g. Pustules 50–100  $\mu$ , subglobose. . . . . *P. Myricae*.
- ee. Upper 2 colored cells fuliginous, lowest olivaceous.
- f. Conidia elliptic-fusoid, 18–22  $\mu$ .
- g. Pustules 50–140  $\mu$  in diam. . . . . *P. stictica*.
- ddd. Setae 15–27  $\mu$ .
- e. Upper 2 colored cells fuliginous or umber, lowest olivaceous.
- f. Conidia clavate-fusoid, tapering.
- g. Pustules subglobose, 80–180  $\mu$ . . . . . *P. Coccolobae*.
- bb. Conidia 19–26  $\mu$ .
- c. Colored cells 12–16  $\times$  4–6  $\mu$ .
- d. Setae 8–16  $\mu$ , arising from different points on rounded apex.
- e. Colored cells very pale olivaceous.
- f. Conidia 18–25  $\mu$ .
- g. Pustules oblong, 220–500  $\times$  100–220  $\mu$ . . . . . *P. unicolor*.
- cc. Colored cells 12–16  $\times$  5–8  $\mu$ .
- d. Setae 4–16  $\mu$ .
- e. Colored cells olivaceous, equally colored.
- f. Conidia elliptic fusoid or elliptic oblong.
- g. Pustules globose-lenticular, 50–130  $\mu$  in diam.
- Setae 5–10  $\mu$ . . . . . *P. Eugeniae*.
- Setae 10–16  $\mu$ . . . . . *P. Melicoccae*.
- Setae 9–20  $\mu$ . . . . . *P. aquatica*.
- ff. Conidia slender fusoid-clavate, tapering.
- g. Pustules globose-conic, 100–225  $\mu$ , setae 3, 9–17  $\mu$ . . . . . *P. disseminatu*.
- gg. Pustules subglobose, 200–250  $\mu$ , setae often 2, 6–14  $\mu$ . . . . . *P. dictaeta*.
- ggg. Pustules lenticular, 160–240  $\times$  80–160  $\mu$ . . . . . *P. Micheneri*.
- gggg. Pustules conic-hemispherical, 75–150  $\mu$ . . . . . *P. microspora*.
- ee. Upper 2 colored cells umber, lowest olivaceous.
- f. Conidia elliptic-fusoid, basal cell obtuse or inflated.
- g. Pustules 200–425  $\times$  170–340  $\mu$ . . . . . *P. foedans*.
- ff. Conidia slender fusoid, acute at base.

- g. Pustules subglobose, 90–225  $\mu$ , distributed without order; setae 6–16  $\mu$  . . . . . *P. Gaultheriae*.
- gg. Pustules globose-conic, punctiform, 100–150  $\mu$ ; setae 9–23  $\mu$  . . . . . *P. neglecta*.
- ggg. Pustules oblong-elliptic, sparse on pine needles; setae 10–16  $\mu$  . . . . . *P. peregrina*.
- gggg. Pustules 75–200  $\mu$ , gregarious, on seeds; setae 8–16  $\mu$ , conidia often torulose . . . . . *P. torulosa*.
- eee. Upper 2 colored cells fuliginous, lowest olivaceous.
- f. Conidia elliptic fusoid, 18–22  $\mu$ .
- g. Pustules subglobose, 50–140  $\mu$  . . . . . *P. stictica*.
- dd. Setae 11–27  $\mu$ .
- e. Median cells olivaceous, equally colored.
- f. Conidia elliptic or oblong-fusoid.
- g. Pustules subglobose, scattered, 80–130  $\mu$ ; setae 9–20  $\mu$ ; colored cells 13–16  $\mu$  . . . . . *P. aquatica*.
- gg. Pustules subglobose, punctate, 100–150  $\mu$ ; setae 18–24  $\mu$ ; colored cells 14–17  $\mu$  . . . . . *P. Lespedezae*.
- ff. Conidia fusoid-clavate.
- g. Pustules subglobose, gregarious, 80–150  $\mu$ ; setae 11–19  $\mu$  . . . . . *P. quercina*.
- ee. Upper 2 colored cells umber, lowest olivaceous.
- f. Conidia elliptic or oblong fusoid.
- g. Pustules subcespitose, punctate, 75–100  $\mu$ ; setae 12–20  $\mu$  . . . . . *P. bicolor*.
- ff. Conidia narrow fusoid, acute.
- g. Pustules globose-lenticular, gregarious, 60–200  $\mu$ ; setae 13–23  $\mu$  . . . . . *P. gracilis*.
- gg. Pustules globose-conic, punctiform, 100–150  $\mu$ ; setae 9–23  $\mu$  . . . . . *P. neglecta*.
- eee. Upper 2 colored cells fuliginous, lowest olivaceous.
- f. Conidia fusoid-clavate, 17–23  $\mu$  long.
- g. Pustules 75–150  $\mu$ , globose-conic, seated without order; setae 12–23  $\mu$ ; colored cells 13–16  $\times$  7–9  $\mu$  . . . . . *P. leprogena*.
- gg. Pustules 75–200  $\mu$ , punctiform, subglobose.
- Setae 15–27  $\mu$ ; colored cells 13–15  $\times$  7–9  $\mu$  . . . . . *P. Coccolobae*.
- Setae 16–25  $\mu$ ; colored cells 12–14  $\times$  6–7  $\mu$  . . . . . *P. Menezesiana*.

- ff. Conidia up to  $26\ \mu$  long.
  - g. Pustules  $150\text{--}250\ \mu$ , seated without order; setae  $20\text{--}28\ \mu$ ; colored cells  $14\text{--}16 \times 7\text{--}8\ \mu$  . . . . . *P. clavispora*.
- ccc. Colored cells  $12\text{--}16 \times 8\text{--}10\ \mu$ .
  - d. Setae  $12\text{--}23\ \mu$ .
    - e. Upper 2 colored cells umber, lowest olivaceous.
      - f. Conidia oblong or elliptic fusoid.
        - g. Pustules punctiform,  $85\text{--}175\ \mu$ , setae  $12\text{--}20\ \mu$  . . . . . *P. japonica*.
      - ee. Upper 2 colored cells fuliginous, lowest olivaceous.
        - g. Pustules punctiform, subglobose,  $120\text{--}160\ \mu$  . . . . . *P. Cliftoniae*.
        - gg. Pustules loosely gregarious, globose-conic,  $75\text{--}150\ \mu$ ; conidia  $7\text{--}9\ \mu$  wide . . . . . *P. leprogena*.
    - dd. Setae  $15\text{--}33\ \mu$ .
      - e. Upper 2 colored cells umber, lowest olivaceous.
        - f. Conidia ovate-fusoid.
          - g. Pustules lenticular,  $160\text{--}250 \times 120\text{--}160\ \mu$ , concentrically disposed . . . . . *P. curta*.
        - ee. Upper 2 colored cells fuliginous, lowest olivaceous.
          - f. Conidia fusoid clavate,  $7\text{--}9\ \mu$  wide.
            - g. Pustules punctiform, subglobose,  $80\text{--}180\ \mu$  . . . . . *P. Coccolobae*.
          - ff. Conidia elliptic fusoid,  $8\text{--}10\ \mu$  wide.
            - g. Pustules pycnoid,  $100\text{--}150\ \mu$  . . . . . *P. sphaerelloides*.
    - cccc. Colored cells  $15\text{--}19 \times 5\text{--}8\ \mu$ .
      - d. Setae  $4\text{--}11\ \mu$ .
        - e. Median colored cells olivaceous or upper 2 umber.
          - f. Conidia slender fusoid, acute at base.
            - g. Pustules globose-lenticular,  $50\text{--}160\ \mu$ , setae  $4\text{--}11\ \mu$  . . . . . *P. Royenae*.
          - ff. Conidia elliptic fusoid, obtuse at base.
            - g. Pustules elongate-lenticular,  $200\text{--}425 \times 170\text{--}340\ \mu$ ; setae  $5\text{--}15\ \mu$ , colored cells  $14\text{--}17\ \mu$  . . . . . *P. foedans*.
        - dd. Setae  $7\text{--}20\ \mu$ .
          - e. Upper 2 colored cells umber, lowest olivaceous.
            - f. Conidia fusoid clavate, acute at base.
              - g. Pustules globose-conic, seated without order,  $100\text{--}225\ \mu$  . . . . . *P. disseminata*.

- gg. Pustules oblong-elliptic on pine needles. . . . . *P. peregrina*.
- ff. Conidia oblong fusoid.
  - g. Pustules hemispherical, gregarious on tubers. . . . . *P. Batatae*.
  - gg. Pustules subglobose, gregarious, 100–200  $\mu$  on fruits. . . . . *P. Psidii*.
- fff. Conidia elliptic-fusoid, broad conic at base.
  - g. Pustules subglobose, punctiform, 175–300  $\mu$ ; colored cells 15–18  $\times$  7–9  $\mu$ ; setae 9–20  $\mu$ . . . . . *P. maculiformans*.
  - gg. Pustules elongate-lenticular, 200–425  $\times$  170–340  $\mu$ , gregarious; colored cells 14–17  $\times$  6–7  $\mu$ ; setae 5–15  $\mu$ . . . . . *P. foedans*.
- ddd. Setae 17–30  $\mu$ .
  - e. Median cells umber or olivaceous, equally colored.
    - f. Conidia elliptic fusoid.
      - g. Pustules subglobose, 100–150  $\mu$ . . . . . *P. Lespedezae*.
  - ee. Upper 2 colored cells umber or fuliginous, lowest olivaceous.
    - f. Conidia obovate-fusoid, 15–18  $\times$  7–9  $\mu$ .
      - g. Pustules long hystericiform, 500–1000  $\times$  100–300  $\mu$ . . . . . *P. scirpina*.
    - ff. Conidia oblong-elliptic, 15–16  $\times$  5–7  $\mu$ , basal cell obtuse.
      - g. Pustules subglobose, 100–250  $\mu$ . . . . . *P. Vaccinii*.
- cccc. Colored cells 15–19  $\times$  8–11  $\mu$ .
  - d. Setae 9–20  $\mu$ .
    - e. Upper 2 colored cells umber, lowest olivaceous.
      - f. Conidia broad fusiform, 22–28  $\times$  7–9  $\mu$ .
        - g. Pustules subglobose, punctiform, 175–300  $\mu$ . . . . . *P. maculiformans*.
    - ee. Upper 2 colored cells fuliginous, lowest olivaceous.
      - f. Conidia broad clavate.
        - g. Pustules subglobose, 175–325  $\mu$ . . . . . *P. glandicola*.
- dd. Setae 17–40  $\mu$ .
  - e. Upper 2 colored cells umber, lowest olivaceous.
    - f. Conidia elliptic fusoid, basal cell broad conic.
      - g. Pustules globose-lenticular, 150–300  $\mu$ , setae 23–40  $\mu$ . . . . . *P. Sydowiana*.

- ff. Conidia broad clavate, basal cell long conic.
- g. Pustules small, conic . . . . . *P. caffra*.
- ee. Upper 2 colored cells fuliginous, swollen, lowest olivaceous.
- f. Conidia broad fusiform, basal cell broad conic: pustules subglobose.
- g. Pustules densely gregarious, 140–420  $\mu$ ; setae 2–3, sometimes branched, 17–27  $\mu$  . . . . . *P. Rhododendri*.
- gg. Pustules 75–225  $\mu$ , scattered; setae 3, simple, 18–27  $\mu$  . . . . . *P. versicolor*.
- ggg. Pustules 100–200  $\mu$ , punctiform; setae 17–35  $\mu$ , simple . . . . . *P. longiseta*.
- gggg. Pustules 100–150  $\mu$ , seated without order; setae 18–26  $\mu$ , simple . . . . . *P. sphaerelloides*.
- ggggg. Pustules oblong-elliptic to hystriform, 150–1000  $\times$  100–300  $\mu$ ; setae 18–27  $\mu$  . . . . . *P. scirpina*.
- ff. Conidia pyriform, basal cell acute.
- g. Pustules 75–200  $\mu$ , globose-lenticular, seated without order . . . . . *P. Tiliae*.
- bbb. Conidia 25–30  $\mu$ .
- c. Colored cells 15–19  $\times$  6–8  $\mu$ .
- d. Setae 8–22  $\mu$ .
- e. Median cells umber, equally colored.
- f. Conidia elliptic-clavate, conic at base.
- g. Pustules globose-lenticular, concentrically arranged, 150–200  $\mu$ ; setae 10–20  $\mu$ , knobbed; colored cells 16–21  $\times$  7–8.5  $\mu$  . . . . . *P. clavata*.
- ee. Median cells olivaceous, equally colored.
- f. Conidia long fusiform, tapering at base.
- g. Pustules subglobose, 125–250  $\mu$ , annulately disposed; setae 15–22  $\mu$ , frequently knobbed; colored cells 17–21  $\times$  6–8  $\mu$  . . . . . *P. annulata*.
- eee. Upper 2 colored cells umber, lowest olivaceous.
- f. Conidia narrow clavate, acute at base.
- g. Pustules hemispherical-applanate, punctiform, 150–225  $\mu$ ; setae 13–30  $\mu$  . . . . . *P. Oxyanthi*.
- ff. Conidia broad fusiform, 22–28  $\times$  7–9  $\mu$ .
- g. Pustules subglobose, 175–300  $\mu$ , punctiform; setae 9–20  $\mu$  . . . . . *P. maculiformans*.

- gg. Pustules hemispherical, gregarious, superficial on tubers; setae 7-16  $\mu$ ..... *P. Batatae*.
- dd. Setae 13-30  $\mu$ .
- e. Upper 2 colored cells umber, lowest olivaceous.
- f. Conidia narrow clavate, acute at base.
- g. Pustules hemispherical-applanate, punctiform, 150-225  $\mu$ .... *P. Oxycanthi*.
- ddd. Setae 25-50  $\mu$ .
- e. Median cells umber, equally colored, 16-21  $\times$  7-8  $\mu$ .
- f. Conidia long fusiform, acute at base.
- g. Pustules concentrically arranged, 75-200  $\mu$ ; setae knobbed..... *P. Theae*.
- cc. Colored cells 15-18  $\times$  8-11  $\mu$ .
- d. Setae 9-20  $\mu$ .
- e. Median cells umber, equally colored, 16-21  $\times$  7-8.5  $\mu$ .
- f. Conidia 25-30  $\mu$ ; setae knobbed.
- g. Pustules 150-200  $\mu$ , subglobose, concentrically disposed..... *P. clavata*.
- ee. Upper 2 colored cells umber, lowest olivaceous, 15-18  $\times$  7-9  $\mu$ .
- f. Conidia 22-28  $\mu$ ; setae not knobbed.
- g. Pustules 175-300  $\mu$ , subglobose, punctiform..... *P. maculiformans*.
- dd. Setae 18-27  $\mu$ .
- e. Upper 2 colored cells umber, basal olivaceous.
- f. Conidia broad clavate, tapering at base, 24-28  $\times$  8-11  $\mu$ .
- g. Pustules small, conic, distributed without order..... *P. caffra*.
- ee. Upper 2 colored cells fuliginous, swollen, lowest umber.
- f. Conidia pyriform, acute at base, 24-29  $\times$  9.5-11.5  $\mu$ .
- g. Pustules globose-lenticular, distributed without order..... *P. Tiliae*.
- ddd. Setae 24-60  $\mu$ .
- e. Upper 2 colored cells umber, lowest olivaceous.
- f. Conidia elliptic-fusoid, 24-28  $\times$  8-9.3  $\mu$ , basal cell broad conic.
- g. Pustules 150-300  $\mu$ , distributed without order..... *P. Sydowiana*.
- ee. Upper 2 colored cells fuliginous, lowest olivaceous, basal cell long conic, tapering.



- f. Conidia broad clavate, gibbous, 27-30  $\times$  8-10  $\mu$ .  
 g. Pustules 75-150  $\mu$ , punctiform ... *P. gibberosa*.  
 ccc. Colored cells 18-24  $\times$  6-9  $\mu$ .  
 d. Setae 10-22  $\mu$ .  
 e. Median cells umber, equally colored, 16-21  $\times$  7-8.5  $\mu$ .  
 f. Conidia elliptic-clavate, obtuse at base.  
 g. Pustules 150-200  $\mu$ , subglobose, concentrically disposed; setae knobbed, 10-20  $\mu$ ..... *P. clavata*.  
 ee. Median colored cells olivaceous, equally colored.  
 f. Conidia long fusiform, tapering at base.  
 g. Pustules subglobose, 125-250  $\mu$ , annulately disposed; setae 15-22  $\mu$ , knobbed, colored cells 17-21  $\times$  6-8  $\mu$ ..... *P. annulata*.  
 dd. Setae 22-50  $\mu$ .  
 e. Median cells umber, equally colored or lowest colored cell olivaceous.  
 f. Conidia long fusoid, tapering at base; colored cells 16-21  $\times$  7-8  $\mu$ .  
 g. Pustules concentrically arranged; setae knobbed, 28-50  $\mu$ ..... *P. Theae*.  
 f. Colored cells 18-24  $\times$  7-9  $\mu$ .  
 g. Pustules usually punctiform; setae not knobbed, 22-34  $\mu$ ..... *P. macrotricha*.  
 bbbb. Conidia 28-35  $\mu$ .  
 c. Colored cells 18-21  $\times$  6-7  $\mu$ .  
 d. Setae 18-24  $\mu$ .  
 e. Upper 2 colored cells umber, lowest olivaceous.  
 f. Conidia long fusoid, acute at base.  
 g. Pustules hysteriform, disposed in series up to 1000  $\mu$ ..... *P. caudata*.  
 aaa. Setae 4 or usually 4.  
 b. Conidia 21-27  $\mu$ .  
 c. Colored cells 15-17  $\times$  6-7  $\mu$ , olivaceous, equally colored.  
 d. Setae 12-17  $\mu$ ; 3 setae arising from uppermost septum, the 4th terminal.  
 f. Conidia fusoid-clavate.  
 g. Pustules subglobose, 120-175  $\mu$ ... *P. montellica*.  
 cc. Colored cells 14-18  $\times$  7.7-10  $\mu$ , olivaceous, equally colored.  
 d. Setae 9-17  $\mu$ .

- f. Conidia elliptic-fusoid, obtuse at base.
    - g. Pustules globose-lenticular, 90–175  $\mu$  . . . . . *P. quadriciliata*.
  - dd. Setae 30–45  $\mu$ .
    - f. Conidia acute at base.
    - g. Pustules hysteriform, 300–700  $\times$  140–250  $\mu$  . . . . . *P. Moorei*.
- bb. Conidia 29–37  $\mu$ .
  - c. Colored cells 20–26  $\times$  8–10  $\mu$ , the 2 upper umber, the lowest olivaceous.
  - d. Setae 20–40  $\mu$ .
    - f. Conidia long fusiform.
    - g. Pustules subglobose, 175–350  $\mu$ , distributed without order. . . . . *P. Planimi*.
- aaaa. Setae 5 or usually 5.
  - b. Conidia 21–29  $\mu$  long.
    - c. Colored cells 14–18  $\times$  7–9  $\mu$ .
    - d. Setae 8–20  $\mu$ .
      - f. Conidia elliptic-fusoid, basal cell broad conic; colored cells olivaceous.
      - g. Pustules subglobose, 150–300  $\mu$  . . . *P. inquinans*.
    - ff. Conidia clavate-fusoid, basal cell long conoid; upper 2 colored cells umber, lowest olivaceous.
    - g. Pustules globose-lenticular, 100–300  $\times$  75–175  $\mu$  . . . . . *P. funerea*.
  - cc. Colored cells 16–20  $\times$  8–10  $\mu$ , olivaceous or umber, equally colored.
  - d. Setae 7–17  $\mu$ , knobbed at extremities.
    - f. Conidia broad fusiform.
    - g. Pustules subglobose, 100–175  $\mu$  . . . *P. Cesatii*.
  - dd. Setae 9–24  $\mu$ , not knobbed.
    - f. Conidia broad clavate.
    - g. Pustules subglobose, 175–300  $\mu$  . . . *P. polychaetia*.
- bb. Conidia 30–40  $\mu$ .
  - c. Colored cells 20–29  $\times$  7–9  $\mu$ , olivaceous or upper 2 colored cells darker than lowest.
  - d. Setae 15–22  $\mu$ .
    - f. Conidia long fusiform.
    - g. Pustules subglobose, 140–275  $\mu$ , distributed without order. . . . . *P. macrospora*.

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# THE SOIL FUNGI OF A PINE FOREST

MARIE BETZNER MORROW<sup>1</sup>

In a comparative study of the micro-flora of soils of different plant associations (2), it was found that large numbers of fungi prevail in the soil of a pine-oak forest in Bastrop County, Texas. Of about forty square miles in extent this area stands out in contrast to the oak-hickory of the surrounding country, its habitat here marking the westernmost limit of loblolly pine in the state. The western limit of pine follows the contact of two geological formations, the pine being restricted to the Mt. Selman formation, which joins the Carrizo. The latter typically supports oak-hickory with mesquite in local areas, mesquite being rather uniformly found along the contact line. The present investigation is restricted to a taxonomic study of the soil fungi from the pine and environs.

## SOILS INVESTIGATED

The following soils were examined: mesquite on the Carrizo geological formation at the pine-mesquite contact; pine on Mt. Selman at the pine-mesquite contact; pine well over in the "pine island" on Mt. Selman formation; and myrtle on ravine banks in the "pine island."

The mechanical analysis of the soils shows the following composition:

Percentage Composition	Mesquite Pine-Mesquite Contact	Pine Pine-Mesquite Contact	Pine Pine-Oak	Myrtle Pine-Oak
Gravel.....	13.0%	43.0%	9.0%	0.3%
Coarse Sand.....	5.0	2.0	1.5	28.0
Medium Sand.....	5.0	5.0	7.0	27.0
Fine Sand.....	4.5	4.0	21.0	15.0
Very Fine Sand.....	18.0	30.0	36.0	18.0
Silt.....	53.0	12.0	19.0	9.0
Clay.....	5.0	3.0	6.0	1.0

<sup>1</sup> The writer wishes to express her appreciation to Dr. I. M. Lewis, Professor of Botany and Bacteriology, The University of Texas, under whose direction the work was carried on, and to Drs. Charles Thom, Principal Mycologist, Bureau of Chemistry and Soils, U. S. Dept. of Agri., Washington, and J. C. Gilman, Associate Professor of Botany, Iowa State College, Ames, Iowa, for help in identifying the species.

The hydrogen ion concentration of the different soils shows the following variation:

pH at 4 inches. . . . .	5.76	6.36	6.23	5.75
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## METHODS

Samples for the fungous study were taken in July, 1930, at depths of 2 and 4 inches for each soil. 1-1000, 1-10,000, and 1-100,000 dilutions were used for plating, plates for each dilution being made in triplicate, and incubated at room temperature for 3-5 days.

Those forms are included that could be directly isolated on an artificial culture medium. Only those species that appeared more than once on a given dilution plate, or on more than one plate, were considered typical for that particular soil. Waksman's synthetic acid glucose agar (11) was used to isolate the fungi, and Czapek's solution agar (10) was used along with Waksman's for the cultural studies. The Mucorales do not grow well on Czapek's.

## RESULTS

Thus far, 13 genera and some 30 species have been identified, as follows: *Absidia subpoculata* Paine, *Cunninghamella elegans* Lendner, *C. echinulata* Lendner, *Hormodendrum olivaceum* Bonorden, *Acrothecium robustum* Gilman & Abbott, *Fusarium elegantum* Pratt, *Cephalosporium curtipes* Sacc., *Monilia brunnea* Gilman & Abbott, *Gliocladium fimbriatum* Gilman & Abbott, *Rhizopus* 2 species (No. 41 and No. 42),<sup>1</sup> *Thielavia terricola* (Gilman & Abbott) Emmons, *Aspergillus niger* group, 3 strains (No. 21, No. 22 and No. 23) Thom & Church, *A. luchuensis* Inui, *A. fumigatus* Fresenius, *A. flavus* group Link, *A. Tamarii* Kita, *A. alliaceus* Thom & Church, *Penicillium* sp. (No. 1), *P. restrictum* Gilman & Abbott, *P. rugulosum* group Thom, *P. fellutanum* Biourge, *P. intricatum* Thom, *P. guttulosum* Gilman & Abbott, *P. chrysogenum* Thom, *P. lividum* Westling, *P. lilacinum* Thom, *P. Thomii* Maire, *Citromyces fuscus* Sopp., and *C. purpureus* Sopp.

<sup>1</sup> The writer's culture numbers.

TABLE I  
DISTRIBUTION OF SOIL FUNGI

	Mesquite Pine- Mesquite Contact		Pine Pine- Mesquite Contact		Pine Pine-Oak		Myrtle Pine-Oak	
	2 in.	4 in.	2 in.	4 in.	2 in.	4 in.	2 in.	4 in.
<i>Penicillium lividum</i> . . . . .					+	+		
<i>P. chrysogenum</i> . . . . .			+					+
<i>P. restrictum</i> . . . . .			+	+	+	+		
<i>P. rugulosum</i> . . . . .			+		+			
<i>P. fellutanum</i> . . . . .	+							+
<i>P. intricatum</i> . . . . .	+	+						
<i>P. guttulosum</i> . . . . .	+	+		+				
<i>P. lilacinum</i> . . . . .	+	+		+				
<i>Penicillium</i> sp. (No. 1) . . . . .						+	+	+
<i>P. Thomii</i> . . . . .	+					+		
<i>Citromyces fuscus</i> . . . . .		+			+		+	+
<i>C. purpurescens</i> . . . . .		+			+		+	+
<i>Aspergillus niger</i> (No. 21) . . . . .					+			
<i>A. niger</i> str. (No. 22) . . . . .	+			+	+	+	+	+
<i>A. niger</i> str. (No. 23) . . . . .	+			+	+	+	+	+
<i>A. luchuensis</i> . . . . .	+			+	+	+		
<i>A. fumigatus</i> . . . . .	+	+	+	+	+	+		+
<i>A. flavus</i> . . . . .		+				+		+
<i>A. Tamarii</i> . . . . .	+	+						+
<i>A. alliaceus</i> . . . . .	+	+						
<i>Absidia subpoculata</i> . . . . .					+	+		
<i>Cunninghamella elegans</i> . . . . .	+	+		+		+		
<i>C. echinulata</i> . . . . .	+	+				+		+
<i>Hormodendrum olivaceum</i> . . . . .					+	+		
<i>Acrothecium robustum</i> . . . . .					+	+		
<i>Fusarium elegantum</i> . . . . .	+		+	+			+	+
<i>Cephalosporium curtipes</i> . . . . .		+						
<i>Monilia brunnea</i> . . . . .	+							
<i>Gliocladium fimbriatum</i> . . . . .	+	+			+			+
<i>Rhizopus</i> sp. (No. 41) . . . . .	+	+		+	+	+	+	
<i>Rhizopus</i> sp. (No. 42) . . . . .	+			+				
<i>Thielavia terricola</i> . . . . .						+		

Table I shows the distribution of the species at the two depths in each soil.

Contrary to the observation of an earlier worker (7) that *Penicillia* are rare in Texas soils, the dominant types in Texas loblolly pine soil seem to be species of *Penicillium* and the closely related genus *Citromyces*, with *Aspergillus* a close second. *Penicillium* and *Aspergillus* species are found in each soil examined, and at both depths. Soil types with high percentages of sand and silt and a pH range of 5.75 to 6.36 appear to be favorable for these species.

Werkenthin's list (7) of fifteen Texas species of fungi isolated from soils of a cotton field near Austin, the campus of the University of Texas, and the greenhouse of the University, at Austin, Texas, includes two species which have been isolated in this study, namely, *Aspergillus niger* and *A. fumigatus*. Ma's list<sup>1</sup> of five *Penicillia* and twelve *Aspergilli* from various soils around Austin, Texas, includes five species of *Aspergillus* and two species of *Penicillium*, strains of which I have found; namely, *A. niger*, *A. fumigatus*, *A. luchuensis*, *A. Tamarrii*, *A. flavus*, *P. restrictum*, and *P. lilacinum*.

In so far as I have been able to find in the literature (1, 3, 4, 5, 6, 7, 8, 9) referring to fungi in Texas soils, and exclusive of Miss Ma's verified unpublished list, referred to above, the following species have not been described before this as having come from Texas soils: *Absidia subpoculata*, *Cunninghamella elegans*, *C. echinulata*, *Hormodendrum olivaceum*, *Acrothecium robustum*, *Cephalosporium curtipes*, *Monilia brunnea*, *Gliocladium fimbriatum*, *Fusarium elegantum*, *A. alliaceus*, *Penicillium chrysogenum*, *P. lividum*, *P. rugulosum*, *P. fellutanum*, *P. intricatum*, *P. guttulosum*, *P. Thomii*, *Citromyces fuscus*, and *C. purpurescens*.

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## NOTES ON THE PYCNIAL STAGE OF PERIDERMIIUM CEREBROIDES

L. S. GILL

(WITH 3 TEXT FIGURES)

The pycnial stage of the common gall-forming caulicolous *Peridermium* on *Pinus radiata* Don, *P. attenuata* Lemmon, and other coastal pines of California has never been reported so far as it has been possible to ascertain. The rust has recently been given the tentative name *Peridermium cerebroides* (?) by Meinecke (6), whose work shows that it is distinct from *Peridermium Cerebrum* (Peck) Hedgc. and Long and strongly suggests that it is a separate form or possibly species for which a valid name is lacking.

In other repeating *Peridermia* the pycnial stage is notably inconspicuous. Meinecke (4, 5, 6) has found it only once in *Cronartium Harknessii* (Moore) Meinecke in the Sierras. Klebahn (3) reports that it does not occur regularly on *Peridermium Pini* (Willd.) Kleb. York (8, 9) does not mention pycnia in his more detailed descriptions of the Woodgate Rust, a point which at least suggests that the stage is not conspicuous. A possible exception to the examples just cited may be the Rocky Mountain form of *Peridermium Harknessii* for which conspicuous pycnia have been described by Weir and Hubert (7), who make no implication that the stage is scarce. On the other hand there is not sufficient experimental evidence available at present to say conclusively whether or not the rust is also facultatively autoecious.

There is no logical explanation for the inhibition of pycnia in these rusts nor, for that matter, is it fully understood how they are formed at all from mycelium which has developed directly from aeciospores, a condition which the inoculation experiments of Klebahn (3) have proven exists in *Peridermium Pini*.

It has been suggested by Jackson (2) that the repeating

*Peridermia* may be "endo" forms, differing from *Endophyllum* in that spore germination is truly aecoid. If such is the case, the production of pycnia could very well be accomplished by atypical nuclear behavior, so common in the reduced rust forms. On the other hand, it is not impossible that the pycnia of *P. cerebroides* (?) which are about to be described signify the presence of a yet undiscovered *Cronartium* stage.

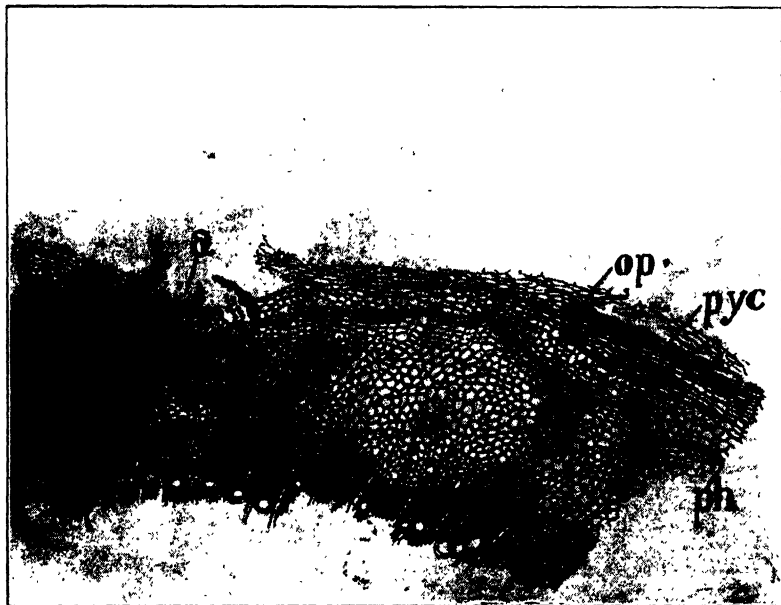


FIG. 1. Cross section through an infected stem of *Pinus radiata* showing aecium *a* arising in the phloem and pycnium *pyc* just under an old layer of periderm *op*. The condition is unusual in that two spore-forms on same gall, and the recently formed layer of phellem *ph* were found in no other case. The usual condition is shown in figure 2. (Drawing traced and slightly reconstructed from an enlarged photomicrograph.)

Pycnia were first noticed on *P. attenuata* in the Santa Cruz Mountains near Boulder Creek, California, at an elevation of about 1500 feet. At this time (Feb. 15, 1930) three galls of approximately a centimeter in diameter on twigs of two young trees about four and eight feet high were found bearing pycnial exudate. The exudate was confined to one or two drops about one millimeter in diameter on each gall; it resembled dark brown molasses in color and viscosity and had a sweet taste. Micro-

scopic examination showed it to contain pycniospores and free-hand sections of the host tissue at the point of exudation revealed a pycnial sorus. A hundred or more galls examined in the field at this time and a number of others which were taken to the laboratory for more critical study showed no signs of pycnia. A few unopened aecia were present.

One week later another stand of *P. attenuata* heavily infected with the rust was visited. This was located about 10 miles southeast of the former station but at least 500 feet lower. A careful field examination there revealed no pycnia. Aecia were rather common but were for the most part unopened. A quantity of short branches bearing young galls 1 to 4 centimeters in diameter were taken to the laboratory. Part of these were immediately examined with the help of a microscope for signs of pycnia but none were found; the rest were kept in the room with their cut ends in water for further observance. Twelve days later a very small gall on one of the latter produced a single drop of pycnial exudate. The others in some cases produced aecia but not pycnia.

A plantation of *Pinus radiata* west of Stanford University at an elevation of 1500 to 1800 feet was examined several times during the month of January 1931. While no exudations or other macroscopic evidences of pycnia were ever found on the rust galls which were abundant there, material collected on two of these occasions showed pycnia when sectioned. Aecia were common but unopened during the first part of the month, but by the 24th they were found in profusion and had begun to open.

A number of old infected Monterey Pines planted on the Stanford campus were studied at frequent intervals during the winter and succeeding spring months of 1930 but no pycnia were found on them. The station in the Santa Cruz Mountains where pycnia were first discovered was visited again in November, 1930, at which time no sign of them could be detected. On January 10, 1931, the pines on Point Lobos and other places about Monterey Bay were inspected but unopened aecia only were found.

Recapitulating for a moment, we see that pycnia were found in the field only once during nearly two years and that internal

sori were found only twice in the scores of galls examined in the laboratory at intervals over the same period. Evidently then, the spore-form occurs rarely and this fact, together with its obscure nature, accounts for its escape from detection in the past. In this connection, the following quotation from Meinecke (6) is of interest:

"It seems likely that, for the two Pacific Coast forms" (*P. cerebroides* and *C. Harknessii*. L.S.G.), "the production of



FIG. 2. Cross section through stem of *Pinus attenuata* showing pycnium in normal position with respect to periderm and phloem.

pycnia is simply repressed but not completely suppressed and that internal pycnia may be found in relatively small numbers."

The general morphology of the pycnium appears to be typical of the other so-called blister rusts (*Peridermia*) of conifers. The mature sori were always found immediately below the periderm, whereas aecia invariably originated at a deeper level in more recently formed phloem. This relationship is shown in figure 1, which however is atypical in that it depicts the only case where both spore forms were found on the same gall and where a phellogen occurred below the pycnium, *i.e.* in all other instances the sorus appeared beneath the last-formed layer of cork as in figure 2. The pycniosporophores in the former

material give the impression of having been compressed, a point which suggests that the pycnium may have become imbedded in cork which was laid down the previous growing season. It cannot be said at this time whether or not aecia and pycnia occur in any regular sequence.

No very young pycnia were found, so that a study of the origin and development of the sorus was impossible. The mycelium on which the sorus is produced is uninucleate. It



FIG. 3. Section of the pycnium on *Pinus attenuata* showing mass of spores *sm*, spores *s*, sporophores *p*, pseudoparenchyma *par*, and host cells *hc*.

forms a mat of pseudoparenchyma  $18\ \mu$  to  $36\ \mu$  thick on which is produced a layer of long straight sporophores (FIG. 3)  $15\ \mu$  to  $30.5\ \mu$  in length. The pycniospores are produced in the usual way by budding from the tips of these. The spores are ovate to slightly pyriform, averaging  $1.7\ \mu \times 3.0\ \mu$  in diameter, they are practically hyaline, but filled with contents which color deeply with various nuclear stains. No attempts were made to germinate them or to determine their possible sexual significance.

The sorus appears to be caeomoid, without peridium or other bounding tissue of fungous origin, and is presumably irregular

in shape, although in none of the cases observed could its outline be clearly distinguished. The greatest distance between the edges of any pycnium studied in cross section was 5.5 mm. These characters stand in marked contrast to extensive and distinct pycnia of *P. Cerebrum* Peck described by Dodge and Adams (1).

#### METHODS

Sections cut from fresh and preserved material were studied in this work. Chrome-acetic and formalin-acetic-alcohol killing agents were used with equal success. The butyl alcohol series was found to be superior to xylol treatment in preparing for paraffin imbedding though it resulted in a slight hardening of the tissues. No special difficulties were encountered in cutting ribbons on a heavy rotary microtome, although paraffin blocks which had been kept under water for a week or more were most easily worked.

The best general stains were Flemming's Triple and the ordinary safranin light green in clove-oil combination. Haidenhain's or Delafield's haematoxylin were best for cytological details. A combination of malachite green and acid fuchsin was found useful in bringing out details of sori. Malachite green and Haidenhain's haematoxylin gave fairly correct differentiation in photomicrographs when panchromatic plates were used without filters.

#### SUMMARY

1. Pycnia of *Peridermium cerebroides* (?) are here recorded for the first time on *Pinus radiata* and *P. attenuata*.
2. The pycnia are rare and considerably smaller than those of *P. Cerebrum*.
3. So far pycnia have been found only on young galls during the winter months.
4. The sorus appears to be borne on uninucleate mycelium and to correspond in most morphological details with typical pycnia of the caulicolous *Peridermia*.

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# THE GENERA OF FUNGI IMPERFECTI<sup>1</sup>

HAROLD B. BENDER

In the course of the preparation of his thesis, "The Genera of Fungi Imperfecti: North American Species and Hosts, with Particular Reference to Connecticut," the writer found five examples where the name given to a previously described genus was employed to designate a more recently described genus.

Accordingly, the writer wishes to change the names of these five more recently described genera:

<i>Coniothyriopsis</i> Petr.	to <b>Coniothyriopsiella</b>
<i>Exosporina</i> Arnaud	to <b>Exosporinella</b>
<i>Pseudodiplodia</i> Speg.	to <b>Pseudodiplodiella</b>
<i>Torulopsis</i> Speg.	to <b>Torulopsiella</b>
<i>Vermiculariopsis</i> v. Höhn.	to <b>Vermiculariopsiella</b>

A generic description of each of these new-named genera, with their respective species, follows.

## **Coniothyriopsiella** nom. nov.

*Coniothyriopsis* Petr. Ann. Myc. **21**: 5. 1923. Not *Coniothyriopsis* Speg. Anal. Mus. Nac. Buenos Aires **20** (Ser. 3, 13): 361. 1910. *C. Hualaniæ* Speg.

Generic Description: Pycnidia in a stroma which is not typical, dothideoid-formed, strongly developed, warty or cushion-formed, more or less outbreaking, with differentiation into a dark colored outer crust and a brighter colored basal tissue, with many round or quite irregular hollow cavities, the stroma quite regularly complete, or incompletely sunken, one to several, to many layered. Conidiophores short, rod-form, simple. Conidia more or less round, short-ellipsoid or ovoid, one-celled, dark, olive brown.

No other species besides the type: *C. insitiva* (Sacc.) Petr. Ann. Myc. **21**: 7. 1923, which now receives the new name, and becomes: **Coniothyriopsiella insitiva** comb. nov.

## **Exosporinella** nom. nov.

*Exosporina* Arnaud, Ann. Epiphyt. **7**: 105. 1921. Not *Exosporina* Oud. Versl. Kon. Akad. Wetensch. Amster-

<sup>1</sup> Contribution from the Osborn Botanical Laboratory.

dam 12: 748. 1904; English translation in Proc. Sect. Sci. Kon. Akad. Wetensch. Amsterdam 6: 501. 1904. *E. Laricis* Oud.

Generic Description: Sporodochia erumpent or remaining free, with or without a slightly stromatic base. Fertile hyphae absent. Conidia in thick chains, also separating singly, one-celled, dark.

No other species besides the type: *E. manaosensis* Arnaud, Ann. Epiphyt. 7: 105. 1921, which now receives the new name, and becomes: **Exosporinella manaosensis** comb. nov.

**Pseudodiplodiella** nom. nov.

*Pseudodiplodia* Speg. Anal. Soc. Ci. Argent. 90: 183. 1920. Not *Pseudodiplodia* Karst. Symb. Myc. Fenn. 16, Meddel. Soc. Faun. Fl. Fenn. 11: 156. 1884. *P. ligniaria* (Karst.) Sacc.

Generic Description: Pycnidia in a hollowed stroma, which is innately superficial, producing chambers with thin walls and without ostioles, black,—the inner wall lighter, and of parenchymatic tissue. Conidiophores simple, hyaline, filiform or absent. Conidia ellipsoid, two-celled, sooty dark brown.

No other species besides the type: *P. aurantiorum* Speg. Anal. Soc. Ci. Argent. 90: 183. 1920, which now receives the new name, and becomes: **Pseudodiplodiella aurantiorum** comb. nov.

**Torulopsiella** nom. nov.

*Torulopsis* Speg. Physis 4: 292. 1918. Not *Torulopsis* Berl. Giorn. Vit. Enol. Avellino 1895: 54. *T. rosea* Berl.

Generic Description: Sterile hyphae creeping on living organisms. Fertile hyphae superficial, black and cottony, small, wooded, cobwebby, somewhat ragged or somewhat crust-like, exhypopodiate. Conidia borne in neck-like chains on the tips, very little distinct from the fertile hyphae, one-celled, dark green.

The type species: *T. fumaginea* Speg. Physis 4: 292. 1918, receives the new name, and becomes: **Torulopsiella fumaginea**. Another species described by Speg.: *T. pseudogyroceras* Speg. Anal. Mus. Nac. Hist. Nat. Buenos Aires 31: 441. 1922, also receives the new name, and becomes: **Torulopsiella pseudogyroceras** comb. nov.

**Vermiculariopsiella** nom. nov.

*Vermiculariopsis* v. Höhn. Ber. Deut. Bot. Gesell. **36**: 317.  
1918. Not *Vermiculariopsis* Torrend, Broteria Bot. Ser.  
**10**: 41. 1912. *V. circinoiricha* Torrend.

Generic Description: Sporodochia superficial, resting on a subicle, cushion-formed provided with black bristles, underneath small-celled, parenchymatic, above with parallel fibers. Fertile hyphae simple or branched, brush-like, tufted. Conidia borne singly on the tips, fusoid to cylindrical, medium in size, bound in a mass with mucus, one-celled, hyaline.

No other species besides the type: *V. immersa* (Desm.) v. Höhn. Ber. Deut. Bot. Gesell. **36**: 317. 1918, which now receives the new name, and becomes: ***Vermiculariopsiella immersa*** comb. nov.

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## NOTES AND BRIEF ARTICLES

### THE RUSTS OF NEW ZEALAND <sup>1</sup>

A knowledge of the rusts has been set forth in an attractive volume by G. H. Cunningham, whose writings on the rusts of New Zealand have received favorable attention for a number of years. The author has not only described the species of rusts occurring in New Zealand, with illustrations and helpful comments, but has prefaced the account with an extended rehearsal of the nature of rusts in general and the historical development of knowledge regarding them.

The volume is consequently divided into two parts. Part I, constituting nearly one half of the volume, consists of ten chapters, "written with a view to bringing together in condensed form matter which has been published in many scores of papers scattered throughout the world's periodicals." How thoroughly this has been done is attested by a very complete bibliography covering 20 pages. The author's intention has been to arrange the different chapters so that the student may obtain a knowledge of structure and behavior that will enable him to comprehend the second part of the work. If this object is defeated it will be due to the unavoidable multiplicity of detail and the inherent complexity of the subject.

Space will not permit more than a cursory view of the chapters. This is less to be regretted, as the author is inclined to be conservative and, while bringing the work down to the present, rarely presents opinions that will not be accepted by nearly every student. It is, therefore, no surprise to find that the first chapter deals with spore forms, which are designated as pycniospores, aecidiospores, uredospores, teleutospores and basidiospores. After a few comments on alternation of generations and sexuality, we pass to the second chapter on germination and viability of spores.

<sup>1</sup> Cunningham, G. H. The rust fungi of New Zealand, together with the biology, cytology and therapeutics of the Uredinales. Printed privately by John McIndoe, Dunedin, N. Z. 1831. 261 pp. 175 figs. in text, 3 pl.

The third chapter is devoted to the entry and penetration of the host, including galls and malformations. The dissemination of the spores finds place in chapter 4, and heteroecism and the host factors that affect parasitism are discussed in chapter 5.

An extended and excellent account of biologic and physiologic specialization as illustrated in the five or six principal cereal rusts occupies chapter 6. The author favors the use of "biologic forms" for the subdivisions of a species often called races or forms, and "biotypes" for secondary subdivisions, a term lately proposed by Scheibe. Although fifteen pages are given to this topic no use is made of the information in the systematic part, partly because the several rusts involved are absent or introduced to a limited extent in New Zealand.

Chapter 7 on therapeutics deals with the methods employed to control rusts affecting cultivated plants. It is in chapter 8 that the author sums up his studies on the relationship of genera and orders, and condenses his views into a well constructed graph. No student interested in the evolution of the rusts should fail to consider the arguments here presented. An excellent and very helpful chapter on technique in its broadest sense fills no. 9, and a few words on classification in chapter 10, showing that no generally acceptable scheme has yet been evolved, close the first part.

In the second part 146 species are described, over one half being endemic. All but six or seven of these endemic species were discovered and made known to the world by Dr. Cunningham, which entitles him to more than usual consideration in a discussion of the rust flora of the country. It also opens up a brilliant future for further study, as 34 species, mostly endemic, are undistributed forms in the form-genera *Aecidium*, *Caeoma* and *Uredo*. There are 33 introduced species, about half falling under the Gramineae and Leguminosae.

In two notable instances, *Puccinia Hydrocotyles* and *P. Dicondrae*, the full life cycle is commonly developed in New Zealand, and nowhere else. In North America the former occurs only as uredinia and has been considered to be a species without aecia, while the latter occurs only as telia, and was believed to be a microcyclic species.

The author is devoted to the International Rules of Nomenclature, especially in accepting 1801 as the initial date for priority, and in ignoring uredo names. The latter leads him, as it has others, into the erroneous statement, that the spores in the type material of the genus *Milesia* "may have belonged to any one of several genera." This is not only a false statement, but it implies that the genus is not distinguished by its urediniospores. The fact is the teliospores have no diagnostic value, except to show that the genus belongs to the Melampsoraceae. They supply no generic or specific characters. Otherwise, how could Dr. Cunningham have placed his new endemic rust on *Histeropteris* in the genus with only uredinia known?

The successful publication of the volume, carried out under trying conditions, is a highly valuable contribution to a better knowledge of the rusts. It is a fitting companion to McAlpine's "Rusts of Australia." It stands on its own merits, however, as only a few species are common to the two countries.—J. C. ARTHUR.

#### MYCOLOGICAL NOMENCLATURE

In spite of international congresses on botanical nomenclature, it appears that mycologists still have a long and difficult road to travel before they will be able to enjoy any degree of stability in nomenclature. In the past, this lack of stability has been caused partially by the fact that there have been two codes of nomenclature, each with its ardent adherents, and partly because of the diversity of personal opinions. Since the former difficulty has been fairly well solved, there remains the latter to be considered. Unfortunately, in so doing, the case becomes rather personal and hence we hasten to state that there is no motive of personal animosity, but rather a fond hope that by this discussion we may help to crystallize opinion on certain phases of the problem of nomenclature.

One of us (Guba, *Phytopathology* **19**: 201–232. 1929) adopted the original generic name *Pestalotia* instead of the later *Pestalozzia*, and at the same time elevated a subspecies to species rank. This subspecies was *Pestalozzia Guepini Vaccinii* Shear (Bull. Torrey Club **29**: 456–457. 1902), which, for some reason not stated, that author has preferred to maintain in a subsequent

paper (U. S. D. A. Tech. Bull. 248: 9. 1931) and of which he made *P. Vaccinii* (Shear) Guba a synonym. The modified name *Pestalozzia* also appears in "The Genera of Fungi," Clements and Shear (New York, 1931).

First let us consider the matter of the choice between the two names. The change from *Pestalotia*, as the name was originally spelled by de Notaris (*Micromycetes italici*. Dec. II. Mem. Acad. Sci. Torino II. 3: 80-81. 1839), to *Pestalozzia* apparently was made by Corda (*Ic. Fung.* 5: 34. 1842) but Fairman (*Mycologia* 5: 245. 1913) was the first to return to the original spelling, being influenced to do so by the competent opinions of Dr. Barnhart, Librarian of the New York Botanical Garden, and Professor Henry F. Burton of the Department of Latin in Rochester University. Dr. Barnhart rendered the opinion that *Pestalotia* is as euphonious as *Pestalozzia* and preferable to it, as it shows an Italian botanist's view of the correct Latinization of an Italian name. Dr. Burton opined that *Pestalotius* is undoubtedly the correct Latin form for Pestalozzi: classical Latin has no "z" sound or character except in a few words borrowed from the Greek. The "z" or "zz" often stands for the Latin "t" or "ti" as in Palazzo (Palatium), Arezzo (Arretium), Firenze (Florentia) and Venezia (Venetia).

While the writers feel that the use of *Pestalozzia* might possibly be condoned on the ground of usage, yet if we accept usage in this case, we cannot accept the name *Helicoum* as proposed by Shear in "The Genera of Fungi" since *Helicoön* was the name originally given to the genus by Morgan (*Cincinnati Soc. Nat. Hist. Jour.* 15: 50. 1892), and is the name that has been used exclusively since that time. If the proposed name is a correction, certainly usage cannot be assumed; then Shear's position is inconsistent. Furthermore, we feel that, in contrast to the statement to be found on page 15 of "The Genera of Fungi" in which it is stated that "Names of more than six syllables have been shortened in such a manner as to preserve their identity," *Helicoum* resembles *Helicoön* no more than it does *Helicoma* and is more likely to be confused with the latter. We therefore unhesitatingly condemn the practice of name changing on the mere plea of better phonetics and of brevity, and feel that

*the original spelling, even though in error, should be insisted upon.*

There is another phase of the problem of nomenclature that should also be considered, and this is brought up by Shear's treatment of *Pestalotia Vaccinii*. Complications arise through the fact that Desmazières described the species as occurring both on *Camellia* and *Magnolia*. His description and illustration of *P. Guepini* (Ann. Sci. Nat. II. 13: 182-184. pl. 4, fig. 1-3. 1840) do not fit the specimen of the fungus on leaves of *Camellia* distributed in Desmazières' Pl. Crypt. 22: 1084 nor any other of the numerous later exsiccatae of *P. Guepini* on *Camellia*. Desmazières' colored illustration of *P. Guepini* embraces fig. 1, a leaf of *Camellia* bearing the fungus; fig. 2, a portion of the upper surface of the leaf with acervuli much enlarged; and fig. 3, conidia. The question arises as to whether Desmazières could have selected the fungus on *Magnolia* leaves as a basis for preparing the type description of *P. Guepini* and for his figure of the conidia, rather than the fungus on *Camellia* leaves, since both plants are given as hosts in the type description. This would appear very unusual and unlikely since Desmazières' illustration of *P. Guepini* includes a figure of the fungus on a *Camellia* leaf, and also since the leaves of that host are the only ones distributed in the exsiccata. While the fungus on *Magnolia* would be welcomed for study, it has not been found. Therefore, the fungus on *Camellia* should be considered the type, even though Desmazières' description and illustration of the conidia do not agree with it. Exsiccatae published after the one in question support this view, and if usage adds additional weight, then it would appear that the case is closed.

With the preceding facts in mind, it is difficult to explain Dr. Shear's attitude in regard to *P. Guepini Vaccinii* Shear. He states (*l.c.*) that *P. Guepini Vaccinii* agrees fairly well in many respects with the description and figure of *P. Guepini* and differs decidedly from specimens issued in certain exsiccatae of that species. These exsiccatae agree with Desmazières' specimen of *P. Guepini* on *Camellia*. There is, however, nothing in the type description of *P. Guepini* which might be construed as being in agreement with *P. Guepini Vaccinii*. Desmazières'



description and figure of the conidia are worthless as a basis for comparison. Furthermore, the species on cranberry is entirely different from that on *Camellia*; hence it is difficult to understand why Dr. Shear implied any relationship between the two. In the words of Shear (U. S. D. A. Bur. Pl. Ind. Bull. 110: 39. 1907) "*Pestalozzia Guepini* is given by Farlow and Seymour<sup>60</sup> as occurring on the cranberry but a study of that species indicates that our plant (*P. Guepini Vaccinii* Shear)<sup>22</sup> is a variety at least as indicated and may perhaps be found to be a distinct species." It is therefore surprising that Dr. Shear refuses to recognize the specific rank and distinctness of the fungus on cranberry, and furthermore that he should insist on the use of a trinomial in violation of the International Code.

Without going into an extensive review of "The Genera of Fungi" we find similar misconceptions in regard to the validity of names. For example one of us (Linder, Ann. Missouri Bot. Gard. 16: 227-388. 1929) has made *Lituarina stigmatea* Reiss a synonym of *Helicoma stigmatum* (Reiss) Linder, yet in "The Genera of Fungi" the earlier name is not only recognized but placed in a different, though related, subfamily. A full discussion of the species was given on page 299 in which it was stated that "If, however, Reiss' figures are compared with those of Potebnia, then the identity of the two species, *II. stigmatum* and *II. Sphaeropsidis*, becomes quite evident, since they not only agree in appearance, but also in spore measurements. The fact that Reiss states that the spores are non-septate should not be considered too seriously as an objection since the septa, because of the small size of the spores and their refractive nature, would not be visible except under a high magnification or by the aid of stains. Further evidence of the identity is the similarity of habitat which Reiss states as "auf der Rinde eines durren, feuchtliegenden Ulmenzweiges, welches von Sphärien bewohnt war." Jaap's material occurred on *Diplodia inquinans* and Potebnia's, otherwise admitted by him to be identical with Jaap's *II. niveus*, is stated to be parasitic on *Sphaeropsis pseudo-diplodia*." In view of the fact that Reiss' type is no longer in existence, it must be admitted that there is still room for doubt, yet it seems that the disposition already made is preferable to juggling the species among the various groups of Imperfecti.

Although other examples of a similar nature could be cited, enough has been said to emphasize our second point, namely that, in a monographic study, considerable investigation, tremendous effort and patience, and an equal amount of thought are involved, with the one idea that a more accurate and stable nomenclature might result from such labors. It would therefore seem far better to discard names that are shown to be unacceptable than to carry them along in the literature and thus perpetuate confusion.—E. F. GUBA, Massachusetts Agricultural Experiment Station, Field Station, Waltham, Mass., and D. H. LINDER, Biological Institute, Harvard University, Cambridge, Mass.



DERMATEA BALSAMEA

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## NOTES ON THREE HEMLOCK FUNGI

B. O. DODGE

(WITH PLATES 10 AND 11 AND 1 TEXT FIGURE)

Among the large number of fungi described by Peck as new species was one found by him on *Tsuga canadensis*. It was the first of two species which he described under his new genus *Gelatinosporium*.<sup>1</sup> Several years later he found an ascocarpic fungus on *Abies balsamea*. He described this one as a new species of *Cenangium*, *C. balsameum*.<sup>2</sup>

Early in November 1931, our attention was called to a few small hemlock trees at Scarsdale, N. Y., which were in bad condition. They had been planted in this place a few years previously. Some of the trees had recently died and branches on others were losing their leaves as though infected with some fungus blight. As a rule no fungus fruiting bodies were present, but certain dead branches that had been pruned off were found thickly dotted with conidial fructifications (PLATE 10, *b*) corresponding very well with Peck's *Gelatinosporium abietinum*, as typified by a specimen collected on hemlock by Peck at Greenbush, N. Y., and now at The New York Botanical Garden as no. 2488 of the Ellis collection. It is probably a part of the type.

On the lower ends of some of the same branches of the Scarsdale hemlocks bearing the *Gelatinosporium* were many mature ascocarps of Peck's *Cenangium balsameum* (PLATE 10, *a*). Such an association was noted by Peck<sup>3</sup> for *C. balsameum* var.

<sup>1</sup> Ann. Rep. N. Y. State Mus. 25: 84. 1873.

<sup>2</sup> Ann. Rep. N. Y. State Mus. 38: 101. 1885.

<sup>3</sup> Ann. Rep. N. Y. State Mus. 43: 40. 1890.

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*abietinum*. Thaxter <sup>4</sup> refers to Peck's notice of this association in commenting on specimens of this species in no. 102a, Reliquiae Farlowianae, collected on *Tsuga canadensis*. Nos. 102b and 102c are labeled to indicate that *Gelatinosporium abietinum* is the pycnidial stage of *Cenangium balsameum*. There are several morphological features that would have suggested such a connection. The pycnidia and ascocarps are both blackish-olive colored on the exterior; both kinds of fruit bodies are rather tough gelatinous when wet; the tissues within both tend to be light olivaceous or greenish yellow; the conidia usually show about three septa, as do the ascospores at maturity; both kinds of spores are somewhat curved (PLATE 11, c, e). These similarities afford another example of the sort of parallelisms which Orton <sup>5</sup> pointed out as frequently indicating genetic relationships between conidial and ascocarpic fructifications. Such parallelisms have also been used by Arthur and his colleagues in predicting connections between rust spore-forms.

The conidia from a specimen of the form genus *Myxosporium*, to be noted later, are much broader than are those of *Gelatinosporium* but they also show three or four septa at maturity. *Myxosporium* has been placed among the Melanconiales with 1-celled hyaline spores. The connection between species of *Myxosporium* and *Dermatea* and the advisability of referring *Cenangium balsameum* to *Dermatea* will be noted later.

#### SINGLE SPORE CULTURES

Ten cultures obtained from single ascospores of this "*Cenangium*" on hemlock, and fifteen cultures from single conidia of the *Gelatinosporium* on the same branches, all showed similar characters and the same developmental stages, thus positively confirming the connection suspected by Peck <sup>3</sup> from the proximity of the two kinds of fruit bodies on the same branches.

Growth is slow, especially on Czapek's medium, which it turns brown. Few fruit bodies develop on this medium. A fine whitish mycelium with little aërial growth develops on corn meal agar. A few spore-bearing structures are always formed. On

<sup>4</sup> Mycologia 14: 99-103. 1922.

<sup>5</sup> Orton, C. R. Structural parallelism between spore-forms in the Ascomycetes. Mycologia 7: 21-27. 1915.

dextrose agar the growth at the surface is compact, powdery, and at first cream colored, then isabelline. Fruit bodies are rarely formed on this medium. Potato-dextrose agar seems to be more favorable for normal growth of the fungus. Numerous fruit bodies which show some of the grayish olivaceous color so characteristic of this species are always matured.

*Microconidia.* At the end of about one month in culture on corn meal agar, small whitish to yellowish-tan tubercle-like bodies are formed, either at the surface or beneath the agar. These bodies are more in the nature of small fleshy stromata. A cavity (PLATE 11, *b*) in which quantities of allantoid to hamate microspores (PLATE 10, *e*) come to lie is formed through excess of peripheral growth of wall elements. Mixed in with the microconidia one usually finds a few septate macroconidia. The fruiting structure turns brown as it ages.

*Macroconidia.* In some cases only an incipient micropycnidial primordium with a few microspores is formed in agar cultures. Extending from this point well below the surface, a canal, lined with macroconidia, is formed through the agar (PLATE 10, *c*). This simulates an ostiolar structure, but these conidia are cut off directly from hyphal branches before any definite fruit body is apparent (TEXT FIGURE 1, *b*). A little later the sporogenous elements do become organized into a wall structure which increases in size peripherally and then the conidia are cut off from definite sporophores which now line the irregular cavity (TEXT FIGURE 1, *d*). Fertile knobs of sporogenous tissue protrude inwardly so that a section may suggest a multilocular structure (PLATE 10, *c*), like that of a *Fusicoccum*. The cavity rounds out, however, to become a well organized pycnidium with an opening above, through which the spores are discharged. The ostiole is not definitely limited by papillary growth in the way one finds it in a *Phoma*, for example.

The fruit bodies which are formed so abundantly on potato-dextrose agar in cultures two or three months old, are covered with a fine soft puberulent growth such as one sees on young ascocarps of a *Cenangium*. They have the same form taken by the young microconidial structure shown in plate 11, *b*. Very likely the micropycnidium becomes a macropycnidium directly.

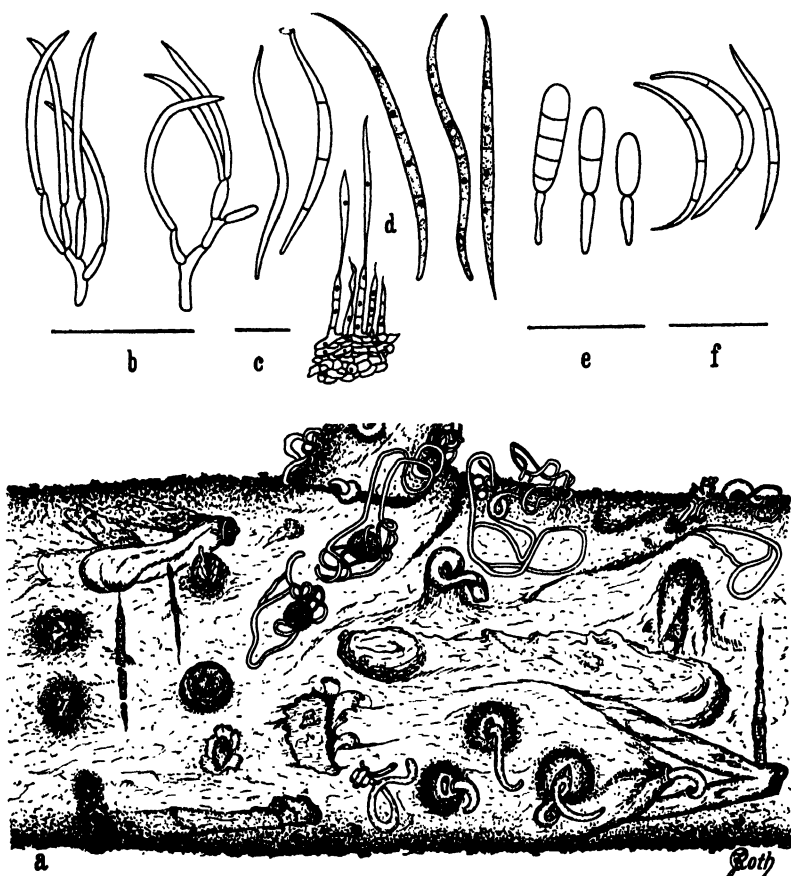


FIG. 1. (a) Sketch of portion of a branch of *Tsuga canadensis* showing discharge of spores of *Gelatinosporium abietinum* in the form of cirrhi; one ascocarp of *Dermatea balsamea* (Peck) Seaver at the left. (b) Conidia arising on sporophores (taken from culture.) (c) Conidium from nature, septa not always readily seen. (d) Conidia and their sporophores from section of pycnidium on a branch. (e) Conidia of *Myxosporium abietinum* Rost. (?) from the same hemlocks. (f) Conidia of *Micropera Abietis* Rost. from Orton's specimen.

Later on some of these structures develop a small hole at the center of the dome through which typical macroconidia exude in long cirrhi. Not all of these bodies, however, produce masses of conidia in this way. In fact the central cavity seems to close up in some of them without producing many conidia and then the structures have a strong resemblance to young ascocarps.

## PYCNIDIA ON BRANCHES

The name *Gelatinosporium* was suggested by the gelatinous spore masses one sees within and about the pycnidia in moist weather (PLATE 10, *b*). Ordinarily the conidia ooze out in long whitish to light greenish cirrhi. Not infrequently several spore horns come out close together (TEXT FIGURE 1, *a*). Sections show that several pycnidia may be formed together, possibly from the same stromatic center. A section of one-half of a pycnidium on a hemlock branch is shown in plate 10, *d*, and a portion of the same structure more highly magnified in plate 11, *a*. These figures prove that there is a very definitely organized wall structure with an opening at the apex. The opening is merely a break in the overlying wall, however. The conidiophores are at first rather long and slender, varying from one to four cells in length (TEXT FIGURE 1, *d*). Each cell has a single nucleus. The tip spins out to a fine point from which the conidia grow out, a new one forming after the old one has broken away. New sporogenous elements arise as the cavity increases in diameter.

The conidia are at first merely allantoid, "more or less curved," Peck says, but later there occurs a peculiar change which is apt to give them a sort of twisted sigmoid appearance. This is brought out in the photograph shown in plate 11, *c*. Under high power one end of the conidium is usually out of focus. The conidia are rather brittle and tend to break off at a septum. The septa which are formed before the spores are mature do not show well in the photographs. Each cell contains a single nucleus (TEXT FIGURE 1, *d*). The "rows of nuclei" mentioned by Peck are merely little portions of cell contents that round up, especially if one puts the twigs in a damp chamber for a few days.

## PATHOGENICITY

Experiments to determine to what extent this fungus is responsible for the dying out of the hemlocks referred to are being carried on. Young hemlocks that had become dormant were brought into the greenhouse and sprayed with spore suspensions. No blighting effects have become manifest as yet. Dr. Glenn Hahn of the U. S. Department of Agriculture is engaged in a study of a number of fungus parasites of conifers.



He writes in part as follows: "We are greatly interested in what you have to say concerning *Cenangium balsameum*. During the past summer I collected a *Cenangium*-like fungus on balsam fir in Maine, which was apparently associated with a die back of the terminal shoots. We found *Micropera Abietis* Rost. associated with this fungus. Unfortunately we were unable to secure cultures of either." This raises the question as to whether *M. Abietis* may not be identical with *Gelatinosporium abietinum*.

There is in the herbarium of The New York Botanical Garden a specimen collected on *Abies balsamea* by C. R. Orton and identified as *Micropera Abietis* Rost. by L. O. Overholts. To judge from its conidia (PLATE 11, *d*) it is not Peck's *Gelatinosporium abietinum*. The conidia are semicircular-arcuate as stated by Rostrup, but they are somewhat longer, 50–60  $\mu$ . They are usually about 3-septate. The conidia of our *Gelatinosporium*, which are shaped like those from the Peck specimen mentioned previously and also like the Farlow specimen (no. 102*b*), are usually about 3-septate and 70–80  $\mu$  long when mature. The septa are not readily seen and might have been easily overlooked by the original authors of both species. Peck's sketch on the Greenbush specimen referred to above actually shows spores with two septa. One finds a few microspores in mounts from Orton's specimen (PLATE 11, *d*, left). Dr. Orton says in a letter: "I collected the specimen in question at Hollywood, N. Y. The disease was in evidence over quite an area in that region, and appeared to be very destructive on young balsam firs at that time." He further referred to an article by Fron,<sup>6</sup> who had found this fungus in fir plantations of the Jura. "He (Fron) was of the opinion that it was the same as Rostrup's fungus which was first described on *Abies pectinata* in Denmark." Fron had compared his fungus with the type of Rostrup's *Micropera Abietis*, and accounted for the smaller size of the conidia in the type specimen by the immaturity of that material. Fron's figure of a spore is very similar to the photograph of spores from Orton's specimen shown in our plate 11, *d*. These conidia, 50–60  $\mu$  long, were certainly mature. Fron's conidia were even

<sup>6</sup> Fron, M. G. Note sur le *Micropera Abietis* Rostrup. Bull. Soc. Myc. Fr. 24: 169–171. 1908.

longer, 60–70  $\mu$ . He also shows that one conidium is formed after another from the tip of the same sporophore. They are cut off in the same way in our *Gelatinosporium*. Very likely there is another species of *Dermatea* ("Cenangium") with *Micropera Abietis* Rost. as its asexual stage just as believed by Rostrup. It is not probable that cultural studies would prove this to be the same as Peck's species. In any event Peck's specific name, *abietinum*, would still hold. Whether one calls it a *Micropera* or a *Gelatinosporium* is of little matter when the ascocarp stage is known. *Micropera* is an older genus name, so that *Gelatinosporium* would become a synonym if *M. Abietis* is a *Micropera* as typified by *M. drupacearum*, which is said to be the asexual stage of *Dermatea Cerasi*. Gregor<sup>7</sup> remarks relative to Rostrup's belief that *Micropera Abietis* is the pycnidial stage of *Dermatea eucrita* (*D. livida*): "Neither *Stilbella* nor *Micropera*, however, shows any resemblance to the true imperfect stage of *D. livida*." She had proved this to be *Myxosporium abietinum* Rost., which has an acervulus fruit body, while it is said *Micropera* has a true pycnidium. There may be still another *Dermatea* on *Abies*.

Dr. F. J. Seaver is now monographing the genus *Dermatea*. The writer is not particularly concerned with the taxonomic aspects of the question, but on consulting with Dr. Seaver as to the identity of the *Gelatinosporium* referred to previously, it was found that he had already placed *Cenangium balsameum* of Peck in the genus *Dermatea* under ***Dermatea balsamea*** (Peck) Seaver, comb. nov., and had considered *Gelatinosporium Abietis* its asexual stage, following the statement on the Farlow specimens (Reliq. Farlow. 102b). This would answer the objection raised by Gregor; and the statement by Dr. Hahn in the quotation from his letter relative to his finding *Micropera Abietis* associated with a *Cenangium*-like fungus is thus understandable.

#### MYXOSPORIUM ABIETINUM ROST.?

On the same branches of hemlock which had been showing so many pycnidia of *Phomopsis occulta*, to be noted below, were

<sup>7</sup> Gregor, Mary J. F. A comparative study of growth forms within the species *Dermatea livida* (B. & Br.) Phill. Ann. Bot. 45: 73–90. 1931. :

found some fruiting bodies which were originally taken to be a *Hendersonia* or a *Coryneum*. The spores which are borne on long thick stalks (PLATE 11, *f*, and TEXT FIGURE 1, *e*) are at first 1-celled and hyaline. Later they become somewhat colored, light olivaceous or slightly brownish and 3- to 4-septate. The number of septa is variable, however. Gregor<sup>5</sup> has given us a detailed account in which the relationship between *Dermatea livida* (Berk. & Br.) Phillips and *Myxosporium abietinum* Rost. is discussed. Cultures from single conidia of our fungus suggest that it is a good *Myxosporium* and probably *M. abietinum*. The conidia are about 25–37  $\mu$  long and 12–13  $\mu$  wide. Practically all of the mature spores show three or four septa and then tend to germinate in the old cultures. Microspores of the form and size ( $5-6 \times 1.5-2 \mu$ ) of those figured by Gregor are also produced in our cultures. Dark colored tubercle-like to flatly conical fruit bodies are formed either on or beneath the surface of the agar medium. In some cases at least, the conidia are formed in a cavity in a structure which breaks open so that the conidia spread out in masses. Some might prefer to call these structures pycnidia. In any event in its morphology and cultural characters this species is quite distinct from *Gelatinosporium* and it can not possibly be connected with *Dermatea balsamea* (Peck) Seaver, although the *Myxosporium* conidia do more nearly resemble ascospores of *Dermatea*.

#### DIAPORTHE CONORUM

Certain small branches of the hemlocks which showed some browning of leaves were put in damp chambers. Some time later many more leaves began to turn brown near the point of attachment and, shortly after, they would fall off showing a *Phomopsis* pycnidium at this point. Similar pycnidia soon developed not only on the branches but, finally, directly on the leaf blades. This fungus was certainly growing vigorously on leaves and twigs that were still green. Dr. Hahn, who identified this fungus as *Diaporthe conorum*, of which *Phomopsis occulta* is the pycnidial stage, says that it may occur as a secondary parasite on conifers weakened by unfavorable growth conditions. Many single spore cultures were obtained by germinating the

*Phoma* type of spores, but the stylospores did not germinate. No blighting effects followed directly the spraying of spore suspensions on dormant hemlocks brought into the greenhouse.

The writer is indebted to Miss Marjorie Swift, who made the single spore cultures and slide preparations for this study, and to Dr. Glenn Gardner Hahn, who identified the *Phomopsis*, and is engaged in making a further study of the pathogenicity and taxonomic aspects of these fungi.

#### SUMMARY

Three different species of fungi were found on branches of certain small hemlock trees that were showing signs of some fungus blight. The most conspicuous species was identified as *Dermatea balsamea* (Peck) Seaver (*Cenangium balsameum* Peck). Single ascospore cultures produce micropycnidia. The microspores are of a type somewhat like the stylospores of a *Phomopsis*. Well organized pycnidia with slender flexuose slightly twisted sigmoid macroconidia develop later. This asexual stage is *Gelatinosporium abietinum* Peck and it is essentially a *Micropera*, as indicated by von Höhnelt.

The identity of species of the *Myxosporium* found on the same dying branches of the hemlocks is uncertain because the ascocarpic stage was not found. It may be *Myxosporium abietinum* Rost., which has been connected with *Dermatea livida* by Gregor. *Micropera Abietis* Rost. has been reported by several persons as occurring on blighted branches of balsam fir. It appears not to be identical with *Gelatinosporium abietinum*. It probably is connected with some other species of *Dermatea*.

*Phomopsis occulta*, which is the asexual stage of *Diaporthe conorum*, was found as a secondary parasite on the same hemlocks.

The pathogenicity of the three species of fungi studied is being investigated further.

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## EXPLANATION OF PLATES

## PLATE 10

*Dermatea balsamea* (Peck) Seaver. *a*, Dead branch of *Tsuga canadensis* showing mature ascocarps of Peck's *Cenangium balsameum*. *b*, Dead branch showing pycnidia of the *Gelatinosporium abietinum* stage. Whitish rings are masses of conidia spread out because of moist conditions. *c*, Section of a young pycnidium in agar culture. The mass of macroconidia above seems to be dissolving away the agar to provide an opening. No ostiole is organized. *d*, Section of a mature pycnidium from a hemlock branch. The wall and sporophores are shown better in plate 11, *a*. *e*, Microconidia from cultures. A few macroconidia also present. *f*, Asci. *g*, *h*, Ascospores.

## PLATE 11

*a*, Section of a pycnidium of *Gelatinosporium abietinum* showing wall tissues, sporophores and origin of conidia. Each cell has a single nucleus. *b*, Section of a micropycnidium from cultures; cavity contains masses of microspores. *c*, Twisted, slightly sigmoid macroconidia. *d*, Macroconidia of *Micropera Abietis* Rost. from Orton's specimens. A few microconidia are visible. *e*, Ascus of *Dermatea balsamea* showing 3-septate spores. *f*, Conidia of the *Myxosporium abietinum*? found on the same hemlocks. *c* and *d* are equally magnified for comparison.



SPECIES OF DERMATEA



# A PHYSIOLOGICAL AND MORPHOLOGICAL STUDY OF *SAPROLEGNIA PARASITICA*<sup>1</sup>

BESSIE B. KANOUSE

(WITH PLATES 12 AND 13)

The species of water mold that is found commonly on fish and fish eggs in fish hatcheries and in the fresh water lakes and streams belongs to the genus *Saprolegnia*. This fungus has been the source of a great deal of concern to ichthyologists for many years since it has caused and is continually causing severe losses in the propagation of fish. The fungus is widespread not only in America but also in Europe and much attention has been given to control methods.

Mycologists likewise have been concerned with this fungus and references to it are numerous in the literature. A very interesting early ecological and physiological reference is quoted from Ramsbottom (10), who in turn quotes from Spallanzani.<sup>2</sup> An historical review of more recent references has been published by Coker (2).

Coker proposed the name *Saprolegnia parasitica* Coker for the fungus associated with fish and fish eggs. The names *S. ferax* (Guith) Thuret. and *S. monoica* Pringsh. have been applied to the fish parasite, but both of these species form oögonia readily

<sup>1</sup> Papers from the Botany Department of the University of Michigan, No. 372, and from the University Herbarium.

<sup>2</sup> "When a minnow or leech dies under water, even several inches from the surface, and has seldom or never come there but for the purpose of respiration, it will soon be covered with a peculiar kind of long slender mould, while lying at the bottom, as I have repeatedly seen. Various species, some slender, some thicker, others more bushy and slender, grow on different animal or vegetable substances also under water; it then seems more luxuriant, which is a general remark to be made of mould where it imbibes most nutriment. Whence does this mould originate?' He queries whether the mould attacks the fish in the short space of time it spends at the surface of the water. He sees no reason to doubt that mould should not thrive in water just as well as many plants, 'because there are facts which seem to prove the existence of certain species of aquatic mould that are not to be found on terrestrial substances.'"



in culture and also in nature, while *S. parasitica* both in nature and in most conditions of culture remains sterile. It was partly upon this difference that Coker based his specific distinctions.

In this paper the author gives an account of the complete life history of *Saprolegnia parasitica* in which the sexual organs are described for the first time. It is shown that *S. parasitica* differs in important respects from *S. ferax*, *S. monoica*, *S. monoica* var. *glomerata* Tiesenhausen and *S. monoica* var. *vexans* Pieters not only morphologically but also physiologically so that the conception of *S. parasitica* as a distinct species remains sound.

Huxley (3) in 1882 described at length a fungus causing an epidemic in the salmon in the streams in England. He was not working with pure cultures of the fungus and he states that he had no proof of the fact that the sexual organs that he observed really belonged to the fungus in question. Coker (2) in his description of *S. parasitica* guardedly says, "sexual reproduction not observed so far in our form," and further, "That the species is almost or quite without sexual reproduction is evidenced by the fact that only very rarely have oögonia been reported (and then without proof that they belonged to the parasite) notwithstanding the fact that this species has been more studied perhaps than any other in the family." Apinis (1) says of *S. parasitica* in Lettland, "Oögonia nicht entwickelt."

The occurrence of this troublesome fungus in the fish hatcheries in Michigan was brought to the attention of the writer by Dr. Carl L. Hubbs, Director of the Division of Fisheries Research, Museum of Zoölogy, University of Michigan. To him and to members of his staff the writer is indebted for the collections of *S. parasitica* used in this investigation.

The question of sterility in a fungus of this group is always a matter of more than ordinary import. After the well-known investigations of Klebs (7), of Kauffman (6), and of Pieters (8) on species of *Saprolegnia*, it seemed reasonable to infer that, barring the possibility of its being a heterothallic species, oögonia and antheridia could be produced in this species also if the proper environmental conditions could be obtained. The basic hypothesis was that the ability to form reproductive organs was not a lost character, but that it was merely latent and

could be brought into expression by suitable physiological environment. The Klebsian principle of the gradual reduction of food supply as a means of control of vegetative and reproductive manifestations in fungi need only be mentioned as the natural approach to the problem. The results obtained reaffirm once again the correctness of the Klebsian philosophy concerning growth and reproduction in fungi. The results also demonstrate a second principle stressed by Klebs, namely that of specificity. It is shown by the following experiments that, in comparison with other species of the genus, *S. parasitica* has an extraordinarily wide range of adaptability with respect to vegetative and asexual development while its sexual reproduction is more narrowly restricted.

Collections of *S. parasitica* were secured from the following sources: From a sunfish taken from a small lake, Ann Arbor, November 1, 1930; from white fish eggs from the State Fish Hatchery at Bay City, Michigan, November 19, 1930; from a bullhead in the fish laboratory in the Division of Fisheries Research, University of Michigan, November 19, 1930; from a horned dace and from rainbow brook trout eggs from the United States Fish Hatchery at Northville, Michigan, January 23, 1931; and from rainbow trout eggs from the United States Fish Hatchery at Charlevoix, Michigan, March 5, 1931. Unless otherwise stated, all studies reported in this paper were made from cultures derived from single zoöspore isolations obtained from the white fish eggs. Although this collection was chosen arbitrarily as the one with which the special experiments were carried out, cultures made from single zoöspore isolations from each of the other sources were carried for comparative studies.

In addition to the single zoöspore cultures, infected fish, as well as gross cultures of white fish eggs and of rainbow trout eggs, both the original infections and those developed subsequently in the laboratory, were under observation throughout a period of several months. All cultures were kept in a refrigerator at a temperature of 10° C.

#### EXPERIMENTAL

The first experiments consisted of a series of cultures in which fish eggs were used as the substratum. The use of trout eggs

was abandoned almost at the start as their large size made them obviously unsuited to experiments involving the reduction of food supply. White fish eggs which are much smaller were used almost exclusively and even though they are more delicate and require more careful technique in keeping them alive in the laboratory, they were better suited to culture work. Living eggs, dead eggs and eggs that had been sterilized in the autoclave were used. The amounts of water and the number of eggs used were varied in an attempt to reduce the amount of food supply to such proportions that the formation of oögonia and antheridia might be produced on the natural substratum on which the fungus ordinarily grows. From one to six eggs were used in amounts of water varying from 15 c.c. to 500 c.c. In the cultures in which dead eggs were used either sterilized or unsterilized, without reference to the amount of water in which they were placed, the fungus grew luxuriantly and produced zoösporangia and an abundance of chlamydospores but no sexual organs. When living eggs were employed the situation became at once complicated. It involved the handling of a very delicate host that is extremely sensitive to laboratory treatments. White fish eggs die quickly kept in conditions that obtain in a laboratory, especially when the water contained in a culture in which they are used can not be aerated or renewed. Living eggs can be distinguished easily from the dead ones by their translucent or semi-transparent appearance. Dead eggs have at first a white chalky spot and later have a solid white look throughout. The difficulty is increased since it is impossible to do more than thoroughly and carefully wash the fish eggs in an endeavor to free them from any zoöspores from some outside source; consequently the possibility of contaminations is always present.

From one to three living eggs were removed to the culture dishes containing 15 c.c. of sterile distilled water and zoöspores. In all of the experiments in which the eggs died within 48 hours, infection took place on the dead eggs, but as far as could be determined not while they were alive. In the lesser number of instances in which eggs remained alive for more than 48 hours, no infection occurred even after the eggs died. One would infer from this that the zoöspores could not gain access to the living eggs

and that the death of the zoöspores took place before the death of the fish eggs. Even in the event that one of the three eggs remained alive longer than the others, the living one was not infected while the dead ones were immediately attacked. It was never until the telltale white spot appeared on the egg that the fungus seemed to have gained a foothold. If, however, mycelium instead of zoöspores was used as the source of infection, the dead eggs eventually all became infected. The reserves of protoplasm in the mycelium outlive the zoöspores and as new zoöspores are produced from these reserves throughout a relatively long time, it is assumed that some viable ones were present to infect the eggs as soon as they were dead.

A second series of experiments in which fish eggs were used was made in an endeavor to reduce the diffusion or availability of the nutritive supply. Sterilized white fish eggs were embedded in paraffine, using the technique described in a previous paper by the author (5). Single eggs were cut out with a shell of paraffine surrounding each. Some of the paraffine shells were punctured with a sterile needle while others were left sealed. One such egg was used in a capsule containing 20 c.c. of distilled water. Zoöspores were added to these. In the unpunctured ones no infection occurred. In the punctured ones there was a feeble growth of flaccid hyphae bearing at length atypical zoösporangia and chlamydospores. No sexual organs were seen.

Sterilized fly legs, small flies and plump house flies that are used so successfully as media for many species of *Saprolegnia* were tried as culture media for this species. The fly leg cultures were so feeble and the mycelium so impoverished that only a few sporangia and chlamydospores were produced and they were as atypical as those produced in the paraffined fish egg cultures (FIGS. 7 AND 15). In both of these a reduction was effected but it was so drastic that not even a good mycelium could be maintained. Klebs (7) pointed out that it is imperative that a well-nourished mycelium precede sexual reproduction, so that the negative results in these two instances could be predicted from the general macroscopic appearance of the mycelium.

Other fly cultures produced a rapid and luxuriant growth of mycelium with typical zoösporangia and countless chains of

chlamydospores. Many of the secondary zoösporangia were of the branching *Achlya* type instead of the usual proliferating *Saprolegnia* type. In the fly cultures the chlamydospores were the conspicuous feature even in young actively growing cultures and the fungus possessed all of the characteristics that it exhibited when fish or fish eggs were the media.

In another series of experiments hemp seeds were used. Two sterilized seeds were placed in 20 c.c. of sterile distilled water. Zoöspores obtained from the six collections of *S. parasitica* were tried. At the end of 4 weeks many sexual organs in the early stages of development were found in the culture that had been derived from the white fish eggs. The oöspores developed the characteristic heavy walls during the following days. After six weeks a few sexual organs were found also in the hemp seed culture derived from the trout eggs. The cultures from the other sources showed no oögonia and antheridia and this difference together with some others that can not be discussed here leads us to infer that there are undoubtedly physiological forms within the species.

While the foregoing experiments were in progress a series of cultures had been prepared to determine with more exactness, by the use of solutions, the kind and amounts of nutritive material that would favor sexual reproduction. A well-nourished mycelium was obtained by growing the fungus in pea broth for 5 days. It was then washed in sterile distilled water for 1 hour and small pieces of the mycelium of approximately the same size were used as the inocula. The materials found effective by Klebs (l.c.) and by Kauffman (l.c.) were selected as those to be used: haemoglobin, leucin, peptone, maltose, glucose, levulose, sucrose,  $\text{MgSO}_4$ ,  $\text{KH}_2\text{PO}_4$ ,  $\text{Ca}(\text{NO}_3)_2$ ,  $\text{K}_3\text{PO}_4$ ,  $\text{K}_2\text{SO}_4$ ,  $\text{KNO}_3$ . The solutions were prepared in per cents .5 and .1 and were diluted with sterile distilled water to the lower per cents desired. They were not sterilized but were handled with a great amount of care. The culture dishes and the fungus were bacteria free. The cultures were quickly transferred to a refrigerator at 10° C. where they were kept except when examined.

The sugars and salts used were C. P. American manufacture, the haemoglobin and leucin were from pre-war German stock;

Witte's meat peptone was the peptone used in the regular experiments and unless otherwise stated is the one meant. However, other brands were used in comparison: Eimer and Amend, Chassing; Eimer and Amend meat peptone; Eimer and Amend peptone from albumen; Armour and Co. peptone siccum; Fairchild's peptone; Digestive Ferments Co. bacto-peptone; Parke Davis and Co. peptone.

In the experiments in which the salts were used alone, the mycelium was quickly impoverished and soon appeared to be dead. Even in low concentrations, .0125 per cent, they were uniformly detrimental.

In haemoglobin solutions the fungus made an excellent vegetative growth. Even in weak concentrations or with the addition of the inorganic salts the mycelium still grew well and formed many chlamydospores. The number of chlamydospores and their size was in direct proportion to the strength of the solution in which the fungus was growing. Many of them were solitary rather than in chains. They remained in a resting condition throughout several months.

The following per cents were used alone and in combination with varying amounts of one salt in the per cents indicated below.

Haemoglobin alone—.01, .025, .05, .00625, .0125 per cent.

Haemoglobin .0125 and  $\text{Ca}(\text{NO}_3)_2$ ,  $\text{MgSO}_4$ ,  $\text{KH}_2\text{PO}_4$ , .1 per cent.

Haemoglobin .05 and  $\text{Ca}(\text{NO}_3)_2$ ,  $\text{MgSO}_4$ ,  $\text{KH}_2\text{PO}_4$ , .05 per cent.

Haemoglobin .025 and  $\text{Ca}(\text{NO}_3)_2$ ,  $\text{MgSO}_4$ ,  $\text{KH}_2\text{PO}_4$ , .1 per cent.

Haemoglobin .025 and  $\text{K}_2\text{SO}_4$ ,  $\text{K}_3\text{PO}_4$ ,  $\text{KNO}_3$ , .1 per cent.

Haemoglobin .00625 and  $\text{K}_2\text{SO}_4$ ,  $\text{K}_3\text{PO}_4$ ,  $\text{KNO}_3$ , .05 per cent.

Leucin was found to be very effective also for the development of the vegetative stage and was more satisfactory than haemoglobin since it allowed a gradual, vigorous growth of mycelium. Large numbers of zoösporangia of the typical shape and size were produced, and tardily after about two weeks, chlamydospores were formed. They resembled oogonial initials in that they were terminal and were subspherical in shape. The culture looked very much like a culture of *Allomyces arbuscula* Butler with its resting spores. Solutions containing leucin in the

following concentrations were tried; .05, .025, .001, .0125, and .00625 per cents; leucin .025 per cent and each of the three salts  $\text{KH}_2\text{PO}_4$ ,  $\text{Ca}(\text{NO}_3)_2$  and  $\text{MgSO}_4$  .1 per cent. All of these allowed excellent growth of mycelium and the production of zoösporangia and chlamydospores. Leucin .0125 and  $\text{KNO}_3$ ,  $\text{K}_2\text{SO}_4$ ,  $\text{K}_3\text{PO}_4$  in any of these per cents used separately was unfavorable for even vegetative growth. The protoplasm was transformed into zoöspores and the fungus was exhausted.

The four sugars selected were tried both alone and in combination with the inorganic salts with the following results: Sucrose and maltose were used in concentrations separately .05, .025, .0125, .00625 per cents. Levulose and glucose were used in .1, .25, .025, .125, .2, .05, .625, .0125 and .5 per cents. An examination at the end of 8 days and again at the end of three weeks showed clearly that levulose, glucose and sucrose were ineffective for either good vegetative or reproductive growth of this fungus. The mycelium scarcely maintained itself and little if any new mycelium was formed. The additions of salts to these were not helpful. However, maltose was found to be decidedly effective in producing a fine vegetative growth. Normal zoösporangia were produced followed by chlamydospores. Mycelium made an excellent, gradual growth and appeared in many respects like that grown in the leucin solutions. The following combinations of maltose with the addition of a single salt were tried:

Maltose .1 per cent and  $\text{K}_2\text{SO}_4$ ;  $\text{K}_3\text{PO}_4$ ;  $\text{KNO}_3$ ; .025 per cent.

Maltose .0125 per cent and  $\text{K}_2\text{SO}_4$ ;  $\text{K}_3\text{PO}_4$ ;  $\text{KNO}_3$ ; .0125 per cent; .125 per cent and .00625 per cent.

In all of these the mycelium grew well and many chlamydospores that resembled oogonial initials were seen but no oöspores were produced in them.

Peptone was another source of nutrition that proved to be good for the vegetative growth and also to be a stimulus for the production of sexual organs when used with leucin glucose or maltose. Mycelium from the white fish egg isolation was grown in the eight brands of peptone in .05 per cent and in .025 per cent. There were some observable differences in the development of the

fungus in the different peptones but they were relatively insignificant, and at the end of ten days the mycelium in all of the experiments quite uniformly resembled the fungus as it appeared when it was grown on fish eggs. In siccum peptone the mycelium remained entirely vegetative longer than in any of the others, the amount of mycelium in Witte's peptone solutions was constantly less in amount, and in Chassing peptone the zoösporangia were unusually large and numerous. No sexual organs were developed in the solutions when the peptones were used alone. In certain combinations with leucin and with maltose many oögonia and antheridia were formed on the mycelium from the white fish isolation. Only the combinations of peptone with maltose and with leucin that were effective will be given. They were: Witte's peptone .025 per cent and leucin .025 per cent; Witte's peptone with maltose .025 per cent, and with maltose .0125 per cent, and with maltose .05 per cent; Witte's peptone .0125 per cent and maltose .0125 per cent; Parke Davis and Co. peptone .025 and maltose .025 per cents. In the two last named combinations the inoculum was derived from mycelium that had been kept in the laboratory for one year. The characters of the oögonia and antheridia in all of these were similar.

The question of the usability of various brands of peptone was tested in a number of experiments. One series was made using .05 per cent of each of the eight brands separately with .05 per cent of maltose. In a second series .025 per cent of each was used and in a third .0125 per cent. *S. parasitica* from the white fish eggs that had been kept in stock culture in the laboratory for one year and had been grown in fresh pea broth and thoroughly washed in the usual way, was used as the inoculum. At the end of ten days oögonia were observed in the mycelium in two of the solutions; Witte's peptone with maltose, .0125 per cents, and in the Parke Davis & Co. peptone with maltose .025 per cents. It would appear from the absence of sexual organs in the majority of these experiments, that there was either an excess or deficiency of some element or elements in the peptone that caused the variations in the reactions. The significant thing beyond the fact of differences in these brands of proteins is, of course, the fact that sexual organs appeared in



mycelium that had been grown under laboratory conditions for that length of time. It seems to preclude any notion that sexuality was merely the reaction to a forced condition that was brought about by the transference of the mycelium from fish substrata to the decidedly different environments maintained in the experiments. We can infer from this that sexuality is really an inherent capacity of the protoplasm. Witte's peptone used with haemoglobin was not effective as was found by Klebs (l. c.) and by Kauffman (l. c.) for "*S. mixta*."

The addition of salts to the maltose and peptone solutions inhibited the formation of sexual organs. Equal parts of the following per cents were used:

Maltose .025	+ peptone .025	+ $K_3PO_4$ .01
Maltose .0125	+ peptone .0125	+ $K_3PO_4$ .005
Maltose .05	+ peptone .05	+ $K_3PO_4$ .02
Maltose .0125	+ peptone .125	+ $KNO_3$ .0025
Maltose .025	+ peptone .025	+ $KNO_3$ .005
Maltose .05	+ peptone .05	+ $KNO_3$ .01
Maltose .05	+ peptone .05	+ $K_2SO_4$ .01
Maltose .0125	+ peptone .0125	+ $K_2SO_4$ .0025
Maltose .025	+ peptone .025	+ $K_2SO_4$ .005

Since maltose and peptone were found effective in liquid media, a synthetic agar medium was made in which salts were excluded excepting as they are contained in the peptone itself. Maltose .3 per cent, .6 per cent, 1.2 per cent together with Witte's peptone .1 per cent were used. An agar medium containing glucose 1.2 per cent and peptone .1 per cent was tried also. It is, of course, realized that the heat of sterilization brings about changes in the sugars and peptone so that the sources of nutrition are not comparable to those in the unsterilized solutions. On the glucose and peptone agar oögonia and antheridia formed in abundance within seven days. No sexual organs formed on the mycelium grown on the maltose .6 per cent and peptone, but a few appeared on the mycelium grown on the agars in which the .3 per cent and the 1.2 per cent maltose was used. In all there were ultimately produced a large number of spherical chlamydo-spores that resembled immature oögonia. The glucose and peptone

agar was found to be the most satisfactory medium for the development of sexual organs. The same good results were also obtained with mycelium that had been grown one year in stock culture in the laboratory.

#### DISCUSSION OF THE EXPERIMENTAL

It will now be necessary to analyze the foregoing results and try to understand some of the underlying principles that explain the apparently completely sterile condition of this fungus in nature and in most conditions of culture, and the several instances in which sexual organs were produced in culture. Starting with the Klebsian premise that an abundance of nutrition produces vegetative stages only, we find that that is exactly the reaction of this organism to the fish and fish egg substrata. It is so completely true for this fungus that for more than sixty years this fish parasite has been considered sterile. The superabundance of food gives rise to luxuriant mycelium and asexual reproduction. The tremendous numbers of chlamydospores are themselves a special type of reaction of the fungus to transform the almost unlimited food supply into protoplasmic reserves. Some of the environmental conditions established in the above experiments supplied a similar stimulus with the result that the vegetative and asexual dominated in these likewise. This was evident particularly in cultures using fish eggs, fish and flies, as well as in the haemoglobin and pea broth solutions.

In certain other experiments a condition was established in which a restricted vegetative growth was obtained and at the same time a vigorous, functioning mycelium was maintained. The maltose and the leucin solutions with peptone, the synthetic agar cultures with peptone and glucose, with peptone and maltose, as well as the hemp seed cultures represent this second class.

Still other experiments show the lower limits of adaptability as the fly leg, paraffined fish eggs substrata and the various inorganic salt solutions. Here the nutritive supply was so low that not even a good mycelium was produced.

With respect to the first group of experiments the situation is probably this; the nutrient was at once available in quantities,

and no proper check was found sufficient to cause control of the vegetative development and at the same time allow sexual reproduction. The fish and fish egg cultures all showed this condition and the haemoglobin solutions gave the same results.

When we consider the cultures that fall into the second group of experiments we find that there was a *gradual* growth of mycelium and concomitant with this reaction was the formation of a great number of zoösporangia and a small number of chlamydospores. There were formed also a large number of bodies that resembled oögonial initials. By modifying the maltose and leucin solutions by the addition of peptone the physiological environment was changed in some of the solutions to such an extent that sexuality was allowed expression. This is the explanation of the results of the leucin and peptone cultures, the maltose and peptone cultures and the glucose and peptone agar and maltose and peptone agar cultures. In Pieters' work (8) on *S. monoica* he found that a striking feature was "The very large number of oögonia found on the mycelium from .1 per cent and from .2 per cent peptone," while only one third as many were found on the mycelium grown in a solution of maltose and peptone. This is a very different reaction from that found in *S. parasitica*. As Pieters (9) points out, peptone is a complex of uncertain quantities of proteins and inorganic salts, so that in the final analysis it is impossible to ascertain the exact cause of the stimulus for sexuality. It is, obviously, impossible to analyze the conditions that took place in the hemp seed cultures. However, by inference it is partly explainable. The macroscopic appearance of the mycelium grown on hemp seed was sufficiently different from that of the mycelium grown on rich concentrations of the fish egg substrata to indicate radical differences in the physiological reactions. The mycelium on the hemp seed grew slowly forming a moderate amount of straight, shining hyphae although they were very different in appearance from the few flaccid hyphae produced in other slow growing cultures. Notwithstanding the lessened amount of mycelium it was in a vigorous growing condition and did not have at any time the appearance of a weakened plant. Pieters (l. c.) showed that well nourished mycelium is not necessarily coördinate with the

dry weight of the mycelium. This is inferred to be true, also of *S. parasitica*. The cultures of *S. parasitica* that represent the two extremes of good vegetative growth are the hemp seed culture and the fish egg culture. If vigor or well nourished mycelium was to be interpreted in terms of quantity, then the mycelium grown on the fish eggs should have been the mycelium on which the sexual organs appeared, but this was not the case.

The fungus grown on the hemp seeds seemed in many respects to appear more normal, judging by a comparison with what we interpret a well-balanced growth to mean in other species of the genus *Saprolegnia*. The zoösporangia and secondary zoösporangia were very regular in shape and size. The chlamydospores were never as numerous or as large as under certain other conditions and the sexual reproduction was present. The oögonia and antheridia appeared at the end of four weeks. That they appeared so late is undoubtedly a direct positive response to the decreasing amount of nutritive supply available. This is also evidenced by the fact that the amount of protoplasm in the hyphae was very greatly reduced. The hyphae immediately surrounding the seeds were nearly devoid of protoplasm, so that the mycelial web had a semi-transparent appearance.

A comparison will now be made of the results described above with similar physiological work done by other investigators on fungi in this group. Klebs (7) and Kauffman (6) in working with "*S. mixta* de Bary" found that potassium phosphate was particularly effective in increasing the appearance of sexual characters in haemoglobin or leucin solutions. Kauffman also states that potassium nitrate, potassium sulphate or calcium nitrate with leucin, or potassium nitrate with haemoglobin were used successfully. For *S. hypogena* Pringsh. he also found potassium nitrate and potassium phosphate with haemoglobin to be a favorable stimulus. None of these salts were effective in *S. parasitica*. In working with *S. monoica* Pringsh. Pieters (l. c.) found that when a well nourished mycelium was placed in a .05 per cent haemoglobin solution that oögonia were readily formed but that not all of them had antheridia. He states further that "Levulose is used more readily (by *S. monoica*) than other sugars except maltose, and that it has a much greater effect in developing

a tendency toward production of oögonia than maltose has." He states that phosphates exert a marked effect upon the number of oögonia produced in this species. We have shown the use of levulose or phosphates as he describes were ineffectual with *S. parasitica*.

Pieters also studied the reactions of a variety *vexans* Pieters of *S. monoica* that he obtained from a dish of algae from a lake near Ann Arbor. In this species no sexual organs were formed in cultures maintained for a year and a half on flies, on agar, and in solutions of haemoglobin, leucin, peptone, etc. However, sexual organs were produced on the mycelium that was transferred to a solution containing leucin M/200 and levulose M/200. He says, "We seem to have here, therefore, the remarkable case of a variety of *S. monoica* having lost sexuality and recovering it under stimulus of this special combination. . . ."

For *S. ferax*, Coker (8) reports that in 5 per cent maltose and .01 per cent peptone used in equal parts, oögonia and antheridia were produced. He says, "This is the only *Saprolegnia* that forms normal oögonia and eggs in this medium."

The outstanding result of this brief comparison of results shows clearly that each species has a very different set of physiological reactions, but a critical analysis also shows that the underlying principle of reduced supply of nutriment as a means of governing the appearance of sexual organs is applicable to all.

#### MORPHOLOGY

The most conspicuous feature of *S. parasitica* in microscopical mounts of mycelium made from infected fish is the countless numbers of dense chlamydospores. They form long chains that often measure 4 mm. in length, and contain often as many as twenty in a single chain. They are present in such numbers that they make the mycelium appear white, and individual chlamydospores can be seen easily with a hand lens. There are many variations in shape and size depending largely upon the substratum on which the fungus is growing. Some are nearly spherical (FIGS. 5 AND 12), others are long clavate or pyriform (FIGS. 4 AND 7), and still others resemble links of sausage. In some salt solutions they form abnormally in terminal bunches

(FIG. 13) and look not unlike zoösporangia of *Phytophthora* spp. Only slight diagnostic value can be attached to the number, size or shape of these bodies so that these variations can have no appreciable taxonomic significance. The chlamydospores are, however, always so numerous in the mycelium that they present a striking appearance and they undoubtedly will continue to be used as a clue to the determination of the fungus found on fish.

They separate easily from each other (FIG. 14) so that individuals are successfully disseminated. Huxley (4) mentioned this characteristic as conspicuous in the fungus on salmon in England. They regenerate either by sending out stout hyphae or by being transformed into zoöspores. Repeated changes of water will bring about the formation of tremendous numbers of zoöspores. They even form in the droplet of water surrounding a chlamydospore transferred to agar plates.

Another feature concerning the chlamydospores is the formation of tube-like processes through which the zoöspores are liberated. A single terminal chlamydospore just as frequently has several of these tubes as do the chlamydospores in the middle of a long chain (FIGS. 3, 4 AND 8). These tubes, of course, are not homologous with the exit tubes of other oömycetes. The tubes or projections are filled with protoplasm which may be transformed into zoöspores (FIG. 9). Further growth by means of hyphae may take place. The solitary spherical or pyriform chlamydospores strongly suggest oögonial initials. Indeed it is evident that they may remain as chlamydospores, function as zoösporangia or as oögonia with or without antheridia, depending upon conditions of the environment. The empty chains of chlamydospores with their tubes often give the appearance of an old culture of *Allomyces arbuscula* Butler with its chains of empty zoösporangia.

The typical zoösporangia are long cylindrical (FIG. 1). They measure  $180-350+ \times 20-24 \mu$ . There may be a great variation from this shape and size. The first ones formed are very unlike the small irregular sporangia that appear in old mycelium or on mycelium growing in unfavorable conditions, such as are represented by the fly leg cultures (FIGS. 7 AND 15). The secondary

zoösporangia are normally proliferating (FIG. 20), but under some conditions they form as in the genus *Achlya* (FIG. 4). Coker (2) mentions this in his description. The zoöspores are diplanetetic (FIGS. 17 AND 18). They measure  $12\ \mu$  in diameter.

Oögonia and antheridia were observed in four types of cultures discussed previously in this paper. The characters of the sexual organs produced on the solid medium and in the liquid media were similar in most respects. The shape of the oögonia and the place of origin of the antheridial branches were the chief differences. On the solid medium nearly all of the oögonia were spherical and the antheridial filaments were androgynous (FIGS. 27 AND 28). Many oögonia developed without antheridia (FIGS. 29 AND 31). The oögonial walls were sometimes thickened, never pitted, and the basal wall frequently projected convexly far into the oögonial cavity (FIG. 30). The last named feature seemed to be an abnormal reaction. In the liquid environments the oögonia were spherical, subspherical to pyriform or clavate, and many were intercalary. The antheridial branches were always declinous in origin and were very long, slender, winding filaments (FIGS. 22, 23 AND 26). Very few oögonia developed parthenogenetically.

On the mycelium grown on the hemp seeds, the oögonia were either terminal or intercalary (FIGS. 23 AND 26). The walls were very thin, smooth and unpitted. The antheridial branches were declinous in origin. The spherical oögonia measured  $65\text{--}95\ \mu$  in diameter. The pyriform ones reached  $135\ \mu$  in length.

The oöspores number from three to twenty-five. They are subcentric and measure  $18\text{--}22\ \mu$  (FIG. 32). They take on a rich golden-brown color even before the oöspore walls are completed. They usually fill the oögonium though not always. The parthenogenetically formed oöspores were scarce in the hemp seed cultures, frequent in the leucin and peptone solutions, and were abundant on the mycelium grown on the agar media.

The antheridia were always small clavate or pyriform organs. The number on an oögonium varied in the different media. There were seldom more than one antheridium attached to each oögonium in the maltose-peptone, or leucin-peptone solutions, but there were commonly from two to four on each oögonium on the mycelium grown on the hemp seed, while on the agar

medium only one was found. Many suboögonial branches had every appearance of being the beginnings of antheridial branches, but often they developed as slender hyphae instead (FIG. 30). The passage of the contents of an antheridium into an oögonium was watched in one instance.

#### TECHNICAL DESCRIPTION

*Saprolegnia parasitica* Coker (Emend.) Saprolegniaceae, *Pl.* 18. 1923.

*Vegetative plant* filamentous, mycelium forming a dense weft. Chlamydospores abundant, usually in chains of from 3 to 30 in a row; in certain culture media terminal and solitary resembling oögonial initials; variable in shape, long cylindrical, clavate, pyriform or subspherical to spherical; separating easily, regenerating by means of hyphae or by the formation of zoöspores; size variable, tube-like processes common.

*Asexual reproduction* by means of zoöspores. Zoösporangia regular, long cylindrical,  $180-350 \times 20-24 \mu$ , smaller and irregular in shape in old mycelium or in certain culture media. Secondary zoösporangia proliferating, sometimes forming as in the genus *Achlya*. Zoöspores diplanetic though in unfavorable conditions germinating in situ.  $12 \mu$  in diameter.

*Sexual reproduction* by means of oögonia and antheridia. Oögonia terminal or intercalary; pyriform, clavate, subspherical to spherical in shape;  $65-135 \times 60-75 \mu$  or  $65-95 \mu$  in diameter. Walls very thin, colorless, smooth, unpitted. Oöspores variable in number 3-25 (35) usually filling the oögonium; subcentric; colored rich golden-brown. Parthenogenetically formed oöspores frequent in some conditions of culture.  $18-22 \mu$  in diameter. Antheridial branches diclinous or androgynous in origin, the latter long, slender, winding filaments. Antheridia small clavate to subcylindric; 1 to 5 attached to each oögonium.

*Habitat*: parasitic and saprophytic on various species of fish and on fish eggs. Common in Michigan and reported from various parts of the United States and elsewhere.

#### PARASITISM

The whole problem of parasitism of fish and fish eggs is a complex one. In connection with the experiments described



above in which living fish eggs were employed brief comments were made on the difficulty attending the use of eggs as media, since any process of sterilization is ruled out. The same difficulties arise with the use of living fish or fry. The foundations upon which experiments requiring these media must rest are always questionable since there is always the danger of the presence of contamination from spores from some unknown source. In connection with the physiological studies reported herein, a few interesting facts came to light. They are so meager that but little significance can be attached to them, yet they do offer some interesting data.

Some of the trout eggs that were brought into the laboratory November 19, 1930, hatched, and the fry were kept alive in a healthy condition and were to all appearances entirely free from fungus infection. In March, 1931, three of them were isolated for experimentation. One was put into each of three small covered capsule culture dishes, containing 20 c.c. of sterile distilled water. One of the three was killed, one was slightly injured and the third was left unharmed.<sup>3</sup> The dead fry and the injured one were attacked immediately and within three days they were surrounded with a dense web of mycelium. The uninjured fry continued to live in the same healthy condition for two weeks. At that time more zoöspores were added to the water. Infection took place after this last procedure and the fry was killed within two weeks. The hyphae appeared around the mouth parts first. In the last analysis it cannot be said that infection took place here on sound tissue as it is well known that fish are easily injured by continually hitting against the glass walls of aquaria. It is not unlikely that that is what happened here, although it is just as reasonable to suppose that the resistance had been lowered by the extraordinarily poor conditions under which the fish was compelled to live and that it became infected in a weakened condition. The remarkable fact remains that the fry withstood the first onslaught of infection at all.

There are also the interesting questions concerning the infection of living eggs by fungus hyphae. Can tips of growing hyphae penetrate living eggs, or is infection restricted to the germ tube hyphae from zoöspores adhering to the surface of the eggs?

<sup>3</sup> Zoöspores were put into each of the three capsules.

Does infection take place actually before the eggs die, at the time of death or immediately after they die? Observations made on masses of eggs that are brought into the laboratory from the hatcheries indicate that penetration does take place directly into the living eggs by hyphae of vigorously growing mycelium. A single infected egg can form a center of infection and rapidly the eggs surrounding this one will be killed and fastened together by the mycelium into tight knots. Undoubtedly the pressure of growing hyphae on the egg membranes when the eggs are held so tightly together is sufficient to allow penetration of the mycelium into living eggs. It seems rather doubtful that zoöspore infection could cause such rapid invasion as does occur. Infection becomes so disastrous in bulks of eggs within an incredibly short time that it is often impossible to save many of the eggs. Loss of the eggs cannot, however, be said to be exclusively due to fungus infection, as it is well known that large numbers of eggs die because of unfavorable physical conditions alone.

The question seemed to take on a different aspect in the laboratory where only about a dozen or twenty eggs were contained in one-half liter of water. In this situation the pressure of the hyphae on isolated eggs is minimized and it is unlikely that here the fungus can gain entrance into living eggs. Repeated observations showed that living trout eggs that were lying near dead, badly infected ones remained alive for a considerable length of time. Even when infection did take place it was more than probable that it was due to the germ tube of some zoöspore that adhered to the egg, and that infection took place at or near the time of the death of the egg. This resistance of eggs seems to suggest that the entrance by penetration of hyphae must be preceded by some radical change in the egg membranes, enzymatic, toxic or otherwise that accounts for the parasitic reaction of the fungus. A mere loss of vitality in the egg may presumably lower the resistance to a point where the fungus can gain access.

Infected fish are common in aquaria and in lakes. The question of whether they are attacked when they are in a healthy condition and whether death is due to the invasion of the fungus

is a difficult one to study. Huxley (3 and 4) made a careful and detailed study of the epidemics that were occurring in fish in Scottish and British rivers and concluded that healthy fish could be attacked. He stated, further, that upon the return of the salmon to the salt water the fungus was not troublesome. The extermination of the fungus in hatcheries and in the fresh water lakes and streams is, of course, utterly impossible. The only hope in the hatcheries is in using unremitting care in promptly removing infected fish and eggs and in making proper disposal of such material. The established practice in hatcheries of continually removing the infected eggs as soon as they are discovered and also in removing all dead eggs from the trays is of utmost importance. All infected material should be disposed of in such a way that it cannot continue to contaminate the source of water in which fish are being reared. It is scarcely possible to over-emphasize the importance of these two points wherever the propagation of fish is concerned.

#### SUMMARY

1. Isolations of *Saprolegnia parasitica* were made from five localities in Michigan and were taken from five species of fish.

2. Detailed physiological experiments were made on the mycelium derived from a single spore isolation from white fish eggs obtained from the State Fish Hatchery at Bay City, Michigan. The experiments were made to determine if possible whether or not *S. parasitica* was a sterile species as has been supposed.

3. It has been shown that the morphology of this fungus can be controlled largely by modifications of the environmental conditions. These modifications are based upon the Klebsian hypothesis that vegetative and reproductive processes can be controlled by a gradual reduction of the nutritive supply.

4. Oögonia and antheridia were produced on the mycelium in certain experiments tried. This is the first time that sexual organs have been shown to exist for *S. parasitica*.

5. Peptone was found to be the stimulus for sexual reproduction when used in combination with leucin or with maltose in solution, or with glucose or maltose in synthetic agar. Sexual organs were also produced on mycelium grown on sterilized hemp seed in water.

6. The morphological characters are unlike those of other species of the genus and support is thereby given for considering *S. parasitica* a distinct species.

7. The physiological reactions of *S. parasitica* are unlike those reported for related species and the doctrine of specificity is again confirmed.

8. The reactions of the fungus to substrata in nature are discussed. Given a highly concentrated nutritive supply like fish or fish eggs, *S. parasitica* produces an excellent vegetative growth and reproduces only asexually. Countless chlamydospores are produced as the reaction to a superabundance of food materials. Physiological experiments are reported in which the conditions found in nature are approximated. Conditions causing significant differences in physiological reactions are given in detail.

9. A few observations on parasitism are reported.

10. An emended description of the species is given.

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## EXPLANATION OF PLATES

*Saprolegnia parasitica*

## PLATE 12

Figs. 1 and 2. Empty zoösporangium with beginning of secondary proliferating zoösporangia. Typical cylindrical shape of the kind predominating in hemp seed cultures, and in certain concentrations of leucin, haemoglobin, and maltose.

Figs. 3, 4, 5, 6, and 7. Chlamydo-spores formed terminally, showing tubes typical of those seen in many cultures.

Figs. 8, 9, 10, and 11. Chains of chlamydo-spores formed on fish eggs, fish, flies, etc. Many chains are longer than these.

Fig. 12. Solitary chlamydo-spores resembling in size and shape the resting spores of *Allomyces arbuscula*; common in haemoglobin solutions.

Fig. 13. A group of chlamydo-spores showing the atypically clustered arrangement found when grown in solution containing  $K_2PO_4$ .

Fig. 14. Two chlamydo-spores becoming separated from each other.

Fig. 15. Empty chlamydo-spores and regenerating hyphae such as form the *Achlya*-like secondary zoösporangia.

Fig. 16. Two chlamydo-spores, the lower one functioning as a zoösporangium.

Fig. 17. Zoöspores in first swimming state (stained with potassium iodide).

Fig. 18. Zoöspores in second swimming stage.

Fig. 19. Germinating zoöspores.

Fig. 20. Proliferating secondary zoösporangia, formed in .025 per cent maltose solution.

## PLATE 13

Fig. 21. Oögonium with antheridium of androgynous origin from mycelium grown on glucose and peptone agar.

Figs. 22, 23, and 24. Oögonia with antheridia of diclinous origin from mycelium grown on sterilized hemp seed.

Fig. 25. Oögonium with parthenogenetically formed oöspores. This undoubtedly represents a chlamydo-spore that has developed into an oögonium.

Fig. 26. An intercalary oögonium. Note the several antheridia attached from mycelium grown on hemp seed.

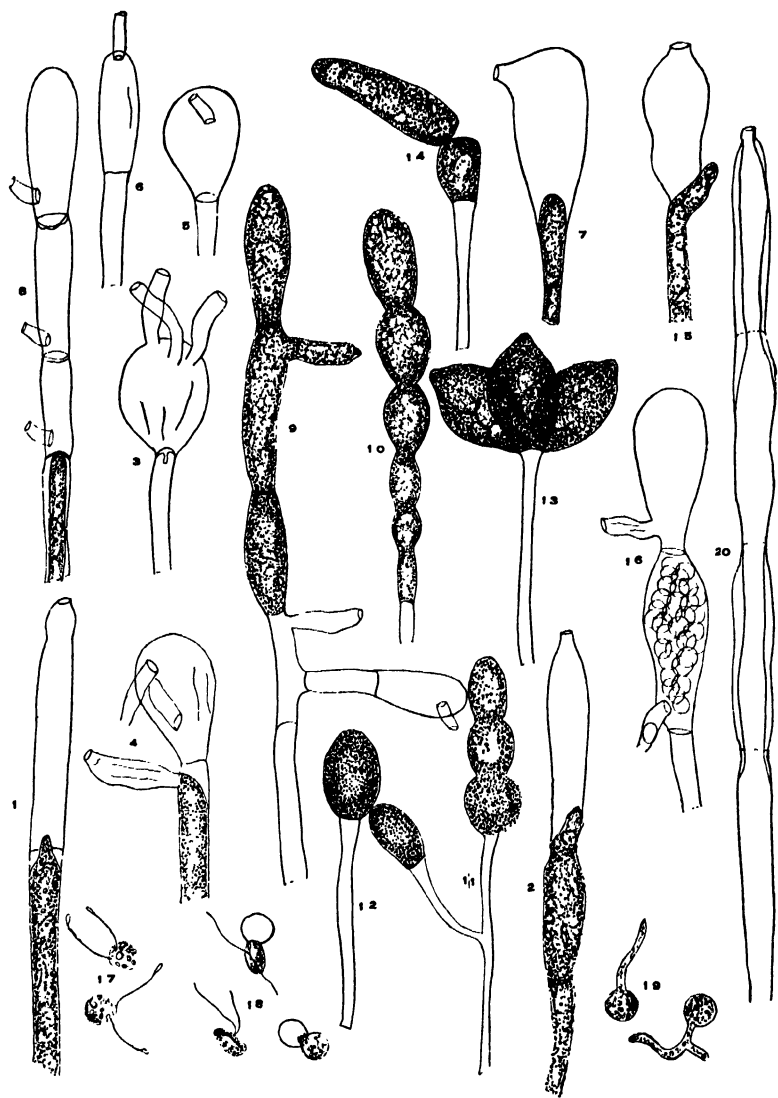
Figs. 27 and 28. Young oögonia with androgynous antheridial branches, from mycelium grown on glucose and peptone agar.

Fig. 29. Oögonium with parthenogenetically formed oöspores. The bulbous branch at the base is not an antheridial branch. If it were, it would be empty before spores were in the advanced stage of development represented in this figure. Many such branches are found in mycelium grown on the synthetic agar medium.

Fig. 30. An oögonium formed on mycelium grown on glucose and peptone agar. Note the thick roughened wall, the basal wall which projects far into the oögonial cavity and the branch from the oögonial filament.

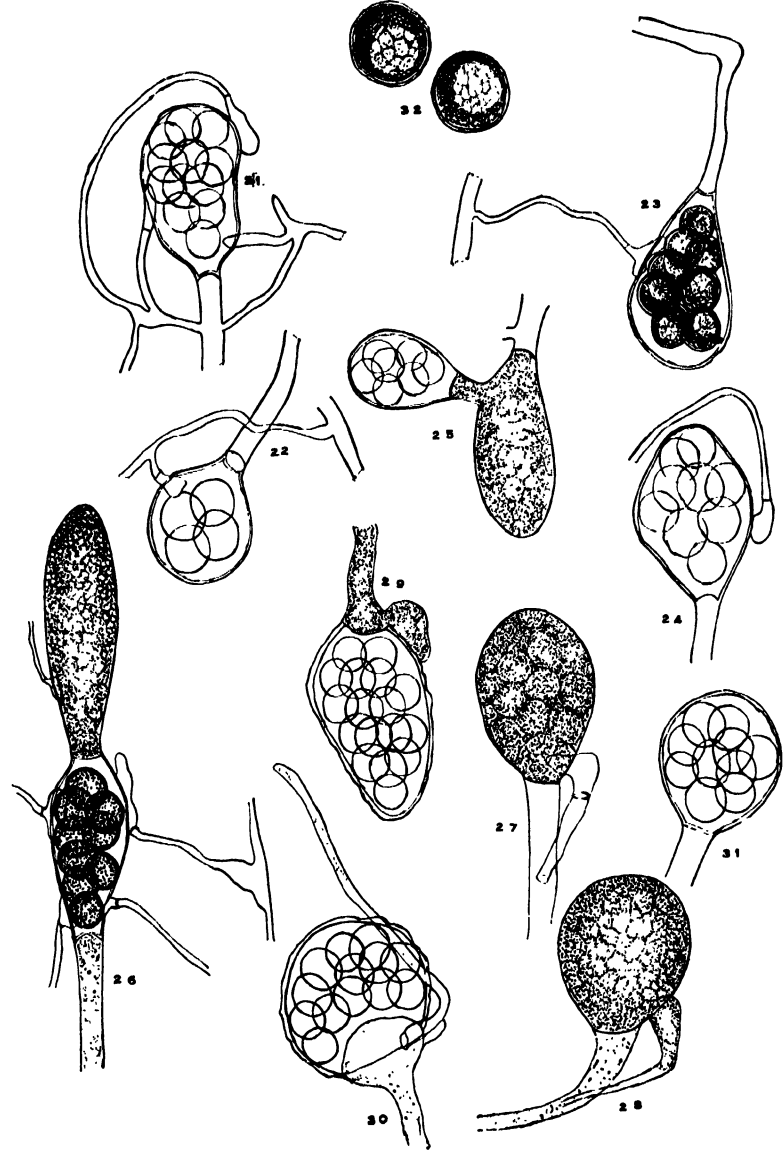
Fig. 31. A small spherical oögonium with parthenogenetically formed oöspores, grown on synthetic agar medium.

Fig. 32. Mature, subcentric oöspores.



SAPROLEGNIA PARASITICA





SAPROLEGNIA PARASITICA





## PSEUDOPYTHIUM PHYTOPHTHORON A SYNONYM OF PHYTOPHTHORA CINNAMOMI <sup>1</sup>

F. P. MEHRLICH

The genus *Pseudopythium*, represented by the single species *Pseudopythium phytophthoron* has been mentioned by Sideris (4) and by Sideris and Paxton (2, 3) as a new genus in the family Pythiaceae, and type cultures have been distributed. A formal description prepared by Sideris was accepted for publication in MYCOLOGIA, and was cited by him as follows:

"Sideris, C. P. Taxonomic studies in the family Pythiaceae III. *Pseudopythium phytophthoron* gen. et sp. nov., a parasite of pineapple plants. Mycologia 23: in Press, 1931."

That author states in his manuscript: "It (this organism) was first considered as a species of *Phytophthora*, but after more careful study it was found that it differed from the true *Phytophthora* type of organisms. The true position of *Pseudopythium* is not well known. The organism can be placed neither in *Pythium* nor in *Phytophthora*, because it has failed, so far, to produce zoösporangia. The morphological characters, however, on which its differentiation and segregation from the other two genera have been based is of such prominence as to justify the creation of a new subgenus in either *Pythium* or *Phytophthora* in case its zoösporangial stage becomes known."

The writer of the present note, in studying the diseases of pineapple with which this organism is associated, has obtained the zoösporangial stage not observed by Sideris. Swollen hyphal vesicles which Sideris termed conidia function as chlamydospores only. The morphology of these vesicles, the proliferation of the zoösporangia, as well as the size and shape of the mycelium, conidia, and zoöspores all agree favorably with the description of

<sup>1</sup> Published with the approval of the Director as Technical Paper No. 36 of the Experiment Station of the Association of Hawaiian Pineapple Cannery, University of Hawaii.

*Phytophthora Cinnamomi* Rands (1). Moreover, repeated studies demonstrate that the pathogenicity of this fungus agrees with that given by Tucker (5) for *P. Cinnamomi* Rands.

Subcultures of two isolations of this organism, which were isolated from separate areas on the island of Oahu, were sent to Drs. L. H. Leonian and C. M. Tucker under the tentative name of *P. Cinnamomi*. Each of these investigators independently verified the designation.

Because of these facts the description of *Pseudopythium phytophthoron* has been withdrawn by Sideris and will not be published. The name thus stands without description as a synonym of *Phytophthora Cinnamomi* Rands. In this light the contributions of Sideris and Paxton, cited below, include additions to the knowledge of the pathogenicity and geographic distribution of this species of *Phytophthora*, regarding which little has been written.

A later paper will consider in detail the morphological and physiological characters which establish the synonymy.

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## A NEW FUNGUS FOR THE UNITED STATES

LEROY DONALD

While out collecting plants for taxonomic purposes in May, 1930, conspicuous galls were noticed at or near the surface of the ground on the stems and leaves of *Veronica arvensis*, the plant commonly known as Corn or Wall Speedwell. Thinking that perhaps this was nematodic injury, some of the material was carried into the laboratory for examination. The examination revealed the presence of a fungus instead which was identified as *Sorosphaera Veronicae* Schr.

Reference is made to the genus *Sorosphaera* in Engler and Prantl's *Die natürlichen Pflanzenfamilien*, I. Teil, Abteilung 1, page 7. Schröter in 1886 listed it as one of four genera under the Phytomyxinae, and made it to include the species *Sorosphaera Veronicae*. In his discussion, three host plants were described from Germany, namely *Veronica hederifolia*, *Veronica triphylla*, and *Veronica Chamaedrys*. In 1895, Rostrup found this species occurring on *Veronica hederifolia* in Denmark. Trotter in 1904 reported the organism in *Veronica arvensis* from Italy. Maire and Tison in 1909 and Blomfield and Schwartz in 1910 conducted a further and more detailed study of the organism, the embodiments of which were published during those years in *Annales Mycologici* and *Annals of Botany*, respectively. In 1929, Cook and Schwartz, while conducting an investigation of the root fungi in ponds and marshes around London, found and described from roots of a number of different grasses growing there a second species of the genus *Sorosphaera* which they named *Sorosphaera radicalis*.

The work on this genus mentioned thus far has been conducted in countries other than the United States, however, and as far as the writer has been able to ascertain, the presence of either species on any host has never been recorded in this country.

As stated by Schröter and corroborated by Blomfield and Schwartz, *Sorosphaera Veronicae* is parasitic in the parenchy-

matous cells of the living plants, causing swellings or tumours. In accordance with the description given by the last mentioned workers, the tumours may be found in various parts of the plant, their most common form being that of swollen stunted stems from which spring a few small deformed leaves. A given plant may have tumours in various stages of development; stems, petioles, and leaves may all show the presence of the fungus. Within the enlarged parenchyma cells of the tumours or swellings may be found the spores which are wedge-like in shape, and united in large numbers within a common membrane to form a spherical hollow ball, varying in size from 15 to 20 microns. Frequently the spore balls or sorospheres may become fused together or united, forming oblong or ellipsoidal compound structures. The tumours or swellings, shortly after the spores have been produced, turn brown and eventually rot, liberating the enclosed sorospheres.

Additional cytological work is being carried forward by the writer with the idea in mind of publishing at a later date a complete and detailed account of his investigations.

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# ON A NEW DAMPING-OFF DISEASE OF TEXAS BLUEBONNETS <sup>1</sup>

J. J. TAUBENHAUS AND WALTER N. EZEKIEL

(WITH 1 TEXT FIGURE)

The Texas bluebonnet (*Lupinus texensis* Hook.) is a native annual plant and the official State flower of Texas. The plant grows in wooded areas, open prairies, and along railroad banks; and seems to thrive well in calcareous, neutral, and even slightly acid soils. The bluebonnet flower is showy, and usually lasts a long time on the plants or when placed in water, and is therefore highly prized as a cut flower. Under field conditions, the plants are very prolific and reseed themselves every year. The seeds usually begin to sprout around January; the plants grow rapidly and are usually in full bloom by March. Bluebonnet plants are very easy to transplant, provided this is done during the month of February, before the plants begin to show flower buds.

Early in January, 1931, Mr. P. B. Monosmith, in charge of the Texas Agricultural and Mechanical College greenhouses, brought in large numbers of plants, which were potted in five-inch pots and placed in a cool house at a temperature of 65° to 70° F. These plants started out well, but before long many of the plants began to lose their normal green color, wilt, and die, and in about ten days the majority of the plants were dead.

Microscopic examination of the crowns and roots of these plants showed a typical damping-off and an abundance of *Rhizoctonia* and *Pythium* hyphae in the decayed tissues. A number of petri-plate cultures were made from infected crowns and roots, and both the *Rhizoctonia* and the *Pythium* were recovered from most of the plants. Microscopic examination of the *Pythium* showed that it resembled closely *P. Debaryanum* Hesse. The *Rhizoctonia* did not produce basidiospores in culture, but its cultural characteristics resembled *Rhizoctonia Solani* Kühn

<sup>1</sup> Published with the approval of the Director as contribution No. 200, Technical Series, of the Texas Agricultural Experiment Station.

as isolated many times by the writers from potatoes, sore shin of cotton, and various infected ornamental plants.

These two organisms were grown on oatmeal agar, and used to inoculate healthy plants in sterilized soil. One hundred five-inch pots were filled with Lufkin fine sandy loam soil material as originally used by Mr. Monosmith, and then steam sterilized for two hours at 15 pounds pressure. These pots were then planted with healthy bluebonnet plants secured from a railroad bank at College Station, Texas. Before planting, the roots and crowns of each plant were washed several times in running tap water and carefully examined for possible infection or lesions, none of which were found. These plants were then quickly dipped in a 1 : 2000 solution of bichloride of mercury and planted in the sterilized soil in the pots, two plants per pot. The potted plants were then placed in the College greenhouse in a cool house. After the plants were well established, twenty-five of the pots were inoculated with the *Rhizoctonia*, twenty-five with the *Pythium*, twenty-five with a mixture of both *Rhizoctonia* and *Pythium*, and twenty-five left as checks. Approximately fifteen grams of the respective oatmeal-agar cultures were mixed with two inches of the moist surface soil of each pot.

The results of these inoculations are shown (FIG. 1 AND TABLE 1). *Rhizoctonia* and *Pythium* used separately or in combination

TABLE 1

INOCULATION OF POTTED BLUEBONNET PLANTS WITH PURE CULTURES OF *Rhizoctonia* AND *Pythium*. (Plants set out in pots January 18, 1931; inoculated February 20; final results March 1, 1931.)

Organism used	No. plants wilting of series of 50	Per cent infection
None (Checks).....	0	0
<i>Rhizoctonia</i> .....	43	86
<i>Pythium</i> .....	49	98
Mixture of <i>Rhizoctonia</i> and <i>Pythium</i> .....	50	100

caused damping-off, while in every case the checks remained normal. Since all the uninoculated, check plants grown in the steam sterilized soil remained normal throughout the experiment, it appears probable that the original occurrence of the disease was from soil infestation rather than from previous infection of

the young bluebonnet plants. By care in the selection of the plants, and soil sterilization with steam, damping-off of Texas bluebonnet plants grown under indoor conditions can apparently be prevented.



FIG. 1. Damping-off of Texas bluebonnets, *a* check, uninoculated; *b*, inoculated with *Rhizoctonia*; *c*, inoculated with *Pythium*; and *d*, inoculated with a combination of both *Rhizoctonia* and *Pythium*.

#### SUMMARY

A new crown-rot and damping-off disease was found on Texas bluebonnet plants transplanted into the greenhouse. The disease was shown to be caused by *Pythium Debaryanum* and a species of *Rhizoctonia*. Both of these organisms were found to be soil-borne, and readily controlled by steam sterilization of the infested soil and disinfection of the young seedlings when transplanting.

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## TWO NEW SPECIES OF LACTARIA

GERTRUDE S. BURLINGHAM

(WITH 3 TEXT FIGURES)

Under the date of December 15, 1909, Prof. George F. Atkinson of Cornell University sent me a specimen of *Lactaria* regarding which he wrote "I am enclosing a specimen of *Lactarius* which I collected in 1904 at Smithtown, L. I., not far from Port Jefferson. Dr. Peck was with me at the time. We both thought it an undescribed species and I have it in my manuscript as *L. villozonatus*. I should be glad to have your opinion of it. You may keep the specimen." He also enclosed full descriptive notes.

Again sometime shortly after 1917 (I have not the date) Prof. Atkinson sent me together with full notes another *Lactaria* which he had named in his manuscript *Lactarius nigroviolascens*. This last summer during the series of mycological forays held at Ithaca in honor of the visit of the Danish Botanist Dr. Jakob E. Lange, some specimens of this same species were collected in a ravine at Mud Creek.

Since Professor Atkinson evidently had never published the description of either of these species of *Lactaria*, it seemed advisable that this should be done, and Dr. H. M. Fitzpatrick, Professor of Mycology, who has charge of the Atkinson Herbarium at Cornell University, suggested that I should arrange for the publication of Professor Atkinson's notes on these two species. He kindly gave me access to the herbarium and has furnished prints from Professor Atkinson's photographs for reproduction in this article.

***Lactaria villozonata*** Atkinson, sp. nov. (as *Lactarius* in the manuscript).

"Pileus depressed, subinfundibuliform, margin first strongly inrolled, villose, pale ochraceous buff to cream buff or whitish, zoned, margin in age usually prominently crenate. Gills narrow subdistant, white, emarginate and adnexed, slowly stained brown where broken. Stem white, smooth, usually tapering downward, sometimes even. Milk watery, taste slowly acrid. Spores white.

Pileo e depresso subinfundibuliformi, pallido-ochracea-isabellina subalbicante, zonata, tempore udo viscida, margine primo involuto villosa demum crenato; lamellis angustis subdistantibus adnexis, subaequalibus simplicibus, albidis jam tactu tarde fulvis; stipite laevi, deorsum attenuato, albo fulvomaculato; lacte aquoso tarde acri; sporae albae.

"Plants scattered or tufted. Pileus 8-12 cm. broad, stem 2-4 cm. long, 1.5-2 cm. thick."



FIG. 1. *Lactaria villozonata*.

Herbarium number 20215. Photograph Roll 1, No. 36.

The dried specimens show a few characteristics not mentioned in this description. The context is not very firm, and from adhering leaves it is plain that the pileus is viscid when moist at least. The lamellae are unequal and simple. The villose condition of the margin is similar to that of *Lactaria resima*. There are fulvous spots of various sizes and shapes on the stipe. Unfortunately the spore description had to be made from spores taken from the lamellae of the dried type specimens instead of from fresh material. The average size is  $6.25 \mu \times 7.5 \mu$ . There are scattered small tubercles on the surface, and when stained with iodine there are some connecting lines.

***Lactaria nigroviolascens*** Atkinson, sp. nov. (as *Lactarius* in the manuscript).

"Pileus at first blackish brown (bistre), then umber and tawny olive as it expands, usually remaining darker in the center, pruinose, more or less rugose, margin at first incurved, in age expanded, the pileus becoming depressed, usually with an umbo, margin at length with short distant striae and crenate,

surface of pileus formed of upright, crowded, slender acuminate cells or hyphae. Gills adnate, decurrent in short lines, subdistant, white becoming ochraceous, in age usually darker. Stem even, colored like the pileus, minutely and densely tomentulose.

Pileo fuliginoso-umbrino, pruinato subrugoso, margine demum striato, stipite subconcolore; lamellis adnato-decurrentibus, subdistantibus, ex albido ochraceis; carne albo, fracta e lacte nigroviolacea; lacte copioso albo non acris; sporae ochroleucae; *L. ligniolae* propinqua sed carne fracta nigroviolascens certe distincta.

"Plants scattered, 5-6 cm. high, pileus 3-5 cm. broad, stems 4-6 mm. stout."



FIG. 2. *Lactaria nigroviolascens*.

"Flesh of stem and pileus white, milk white, abundant, slowly changing to blackish violet as do all wounds of the pileus, stem or gills when milk is present. As the plants become old and dry the milk is less abundant and only portions of the flesh change bright black on the pileus or stem. When the plant is fresh the change is to blackish violet. Spores echinulate, globose, with a large oil drop 8-10  $\mu$ . The species belongs in the *Plinthogalae* section of the genus."

Type locality: Ground, woods, Coy Glen, July 23, 1917. Herbarium number 24257.

The following additional notes are from specimens collected on August 28, 1931 at Mud Creek near Ithaca.

Latex white, abundant, pungent but not acrid, staining the flesh dusky blue violet to plum violet (Ridgway). Spores ochroleucous t-1. Pileus mummy brown (Ridgway) to umber on the margin. Stipe chocolate t-1 to 2. Spores globose echinulate  $10\ \mu$  in diameter inclusive of spines. When stained with iodine fine lines connecting some of the spines appear. I did not find an oil drop present.

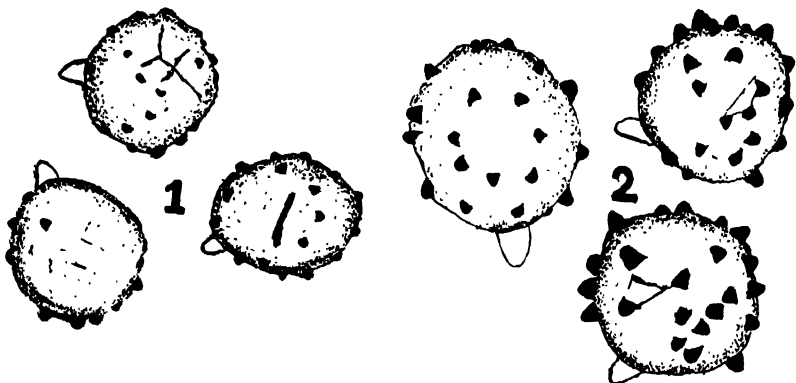


FIG. 3. 1, Spores of *Lactaria villozonata*; 2, Spores of *Lactaria nigroviolascens*.

This species closely resembles *Lactaria ligniota* Fries and may easily be mistaken for it unless one notes the difference in the color change of wounds. I did not find that the color of the latex changed except where in contact with the flesh.

I do not know what color book Professor Atkinson used in describing the color in his notes. In my additional notes I refer to the Repertoire de Couleurs except where otherwise indicated.

The type specimens of both of these species are filed in the Atkinson Herbarium at Cornell University, and one specimen from each is filed in my own herbarium.

The spore drawings have been made with the aid of a camera lucida using a  $1/12$  in. oil immersion lens and a 15 mm. ocular. The spores were stained with an iodine solution made according to the formula recommended by Richard Crawshaw in "Spore Ornamentation of the Russulas."

## NOTES ON SARCOSPHERA FUNERATA

ERDMAN WEST

(WITH PLATE 14)

According to Cooke<sup>1</sup> the type collection of *Sarcosphaera funerata* (Cooke) Seaver was made at Gainesville, Florida, by H. W. Ravenel. Seaver<sup>2</sup> stated that he had seen collections from New Smyrna, Florida; Albion, Michigan; and Melbourne, Australia (?). There seems to be no record that the plant had been collected in the original locality since the type collection was made in 1878. The writer collected several dozen plants along an old road near Gainesville during January and February in 1931, on sandy land that had not been cultivated for at least ten years. The vegetation of the area consisted of wire-grass (*Aristida stricta*) and cactus (*Opuntia* sp.) with plenty of bare ground between the plants. No specimens have been found in this area in 1932, probably because the field had been plowed and a house built on part of it.

In the descriptions given by Cooke and Seaver, there was no reference to a stipe on the apothecium. The right hand specimen on the plate published with Dr. Seaver's article apparently had a short stalk, but this fact was not mentioned in his article. Every specimen of this fungus so far found by the writer has had a stipe, but it was so brittle that it broke off unless the plant was dug with great care. On large plants, this stipe was as much as six centimeters in length and one in thickness, and it was proportionately less on smaller plants. Usually it was slightly longer than the diameter of the cup. It was concolorous with the outer surface of the apothecium and, like it, covered with adhering sand. The lower portion consisted of mycelium with a large proportion of sand. Although it was not mentioned

<sup>1</sup> Cooke, M. C. Ravenel's American Fungi. *Grevillea* 6: 129-146. 1878.

<sup>2</sup> Seaver, F. J. Photographs and Descriptions of Cup-Fungi—XIII—Subhypogaeous Forms. *Mycologia* 22: 215-218. 1930.

in previous descriptions, many of the larger apothecia were plicate towards the base (PLATE 14, FIG. B).

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#### EXPLANATION OF PLATE 14

*Sarcosphaera funerata*—Figure A.—Top view of five apothecia showing the typical star-shaped openings, which alone are visible when the plant is growing in its natural habitat. Figure B.—Lateral view of a plant showing the sand-covered stipe and the creases in the lower part of the cup. Figure C.—Another plant showing the stipe. Half of the cup has been removed to show the hymenium. (All photographs slightly enlarged.)

#### EDITOR'S NOTE

The above paper is a valuable contribution to our knowledge of this species (*Sarcosphaera funerata*). It is an interesting coincidence that just two weeks before this paper was received for publication the writer received from Dr. Lee Bonar, of the University of California, an interesting collection (obtained by one of his students) of the same species for determination with the following notes:

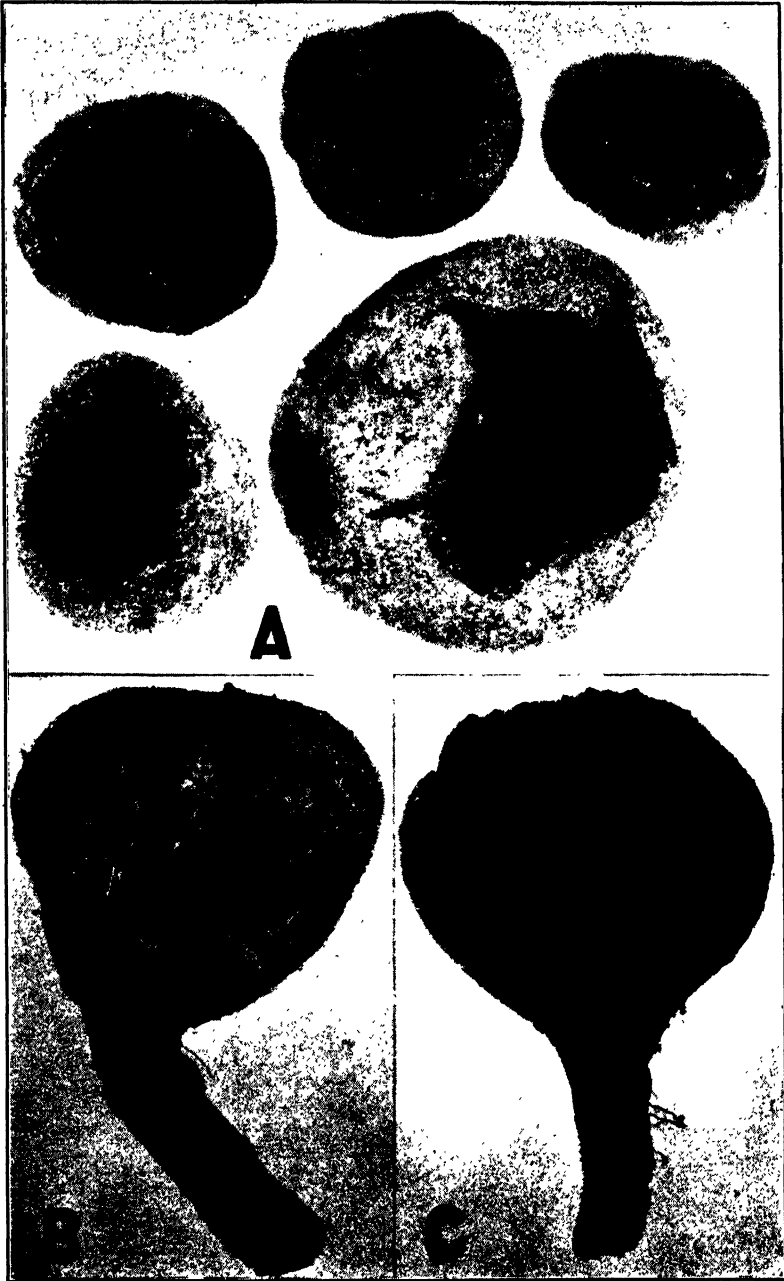
"The younger specimens are almost closed at the top, having a small hole, while the more mature ones are more opened, without any evident splitting down the sides. Exterior, simply the color of the sand which is held tightly to the exterior, in a mesh of whitish woolly hairs. Texture of the cup brittle fleshy, whitish in the sterile tissue, light buff in the hymenial layer. The hymenium is light buff in color, becoming slightly darker in drying to what you can see in the specimens. Asci 290–320  $\times$  10–12 microns. Paraphyses filiform, very slightly enlarged at the tips. Spores smooth hyaline, ellipsoidal, 13–15  $\times$  7–8 microns.

"The peculiar stalk varied in length on all the specimens, and when broken seemed to be largely made up of sand held together by mycelium, without any very evident development of solid fungus tissue within, but characteristic of each specimen, as they came to me."

This is the first record of the species from California. The first collection of this fungus received from Florida was sent by

Dr. Beardslee, who wrote: "I found them in January and February in New Smyrna [Florida]." As indicated above by Mr. West the fungus was collected by him near Gainesville (the type locality) also in January and February, 1931. The California specimen was collected February 24, 1932, so that all three collections from Florida and California were obtained in either January or February.

In the collections by Beardslee no mention was made of a stem which was doubtless broken off in the process of collecting but as indicated by Dr. Bonar the stem appears to be made up of columns of sand held together by strands of mycelium and may not after all be a true stem. He also mentions hairs on the outside of the apothecium but these again are merely strands of mycelium and not regarded as true hairs. The collection of this species in California greatly extends the range of distribution and it is hoped that these notes will stimulate other collectors to look for this little known species.—F. J. SEAVER.



SARCOSPHERA FUNERATA





## NOTES AND BRIEF ARTICLES

### ENCYCLOPÉDIE MYCOLOGIQUE

Volume 1<sup>1</sup> of this work has just been received. This volume consists of 430 pages with 220 text figures and 35 plates in color, the plates containing 880 figures. The text figures consist of drawings of spores, cystidia, and other microscopic characters. The plates are beautifully done and the entire work appears to be a valuable contribution to our knowledge of this genus.

### ANNOUNCEMENT

Under the direction of Dr. G. P. Clinton, the writer completed a thesis with the following title: "THE GENERA OF FUNGI IMPERFECTI: North American Species And Hosts, With Particular Reference to Connecticut." The work was conducted at the Osborn Botanical Laboratory of Yale University, and at the Conn. Agricultural Experiment Station. The dissertation was presented to the Faculty of the graduate school of Yale University, in candidacy for the doctorate degree. The author intends to publish this work in the near future.

The present work attempts to bring about morphological unity in the definition of the various members of the group. It includes a brief history of the classification of the Fungi Imperfecti. The numerous genera shown to be synonyms have been compiled, as well as those which in part have perfect forms. It also includes a comprehensive key to all genera, including recent forms. The author's arrangement of genera is primarily one where a definite form can be located again with least effort. The writer uses conidial characters not at all for the definition of Families,—using such characters for the Genera alone. The definition of the Orders is based upon the type of fruiting body present, and its position in relation to the substratum. In the present work

<sup>1</sup> Heim, Roger.—Le genre *Inocybe*, précédé d'une introduction générale à l'étude des Agarics ochrosporés. Paul Lechevalier & Fils, 12, Rue de Tournon, Paris. 225 franks.

criteria for conidial sections can be uniformly applied to all Genera, irrespective to which larger group they naturally belong.

The writer also presents a detailed survey of the distribution of Fungi Imperfecti found in Connecticut. In addition an attempt is made to indicate, so far as recorded in literature, for each genus, all species found on Connecticut Hosts,—which hosts are also found elsewhere within North America. Thus the survey presented will serve as an indicator of potential invasion of Fungi Imperfecti for most North American hosts. The survey also shows precisely what hosts a species has been recorded as invading.

In describing the 1500 Genera the simplest possible descriptive terms have been used. Similar criteria for description were employed for genera irrespective of family or order relationships. The description for each genus is followed by the name of the perfect form for that genus, or for some of its species. On the same line where the genus, its number, author, and citation of original description are indicated, there appears also in "symbol formation" the classification for that genus. Knowing the salient characters of each generic group indicated by this symbol formation, the reader can by a mere glance at this formation learn the fundamental characters of the genus. Citations for the original description are followed by citations for later descriptions and for species of that particular genus. Also indicated are the generic names of synonyms of that genus.

Following the description of the genus are lists of species with hosts on which the species have been recorded found. Those species with hosts actually found in Connecticut have distribution data for the state. All lists are arranged alphabetically or chronologically.

The total "Generic Key" is itself made up of a number of separate "keys." These are so arranged as to insure accuracy with a minimum of effort.

The present work, then, should serve as a comprehensive reference from which either general or specific information concerning the Fungi Imperfecti can be obtained. Various means are provided for locating such desired information easily and speedily.

HAROLD B. BENDER





# MYCOLOGIA

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## A NEW SPECIES OF BOTRYTIS ON RHIZOMATOUS IRIS

H. H. WHETZEL AND F. L. DRAYTON

(WITH PLATES 15 AND 16 AND 1 TEXT FIGURE)

On at least seven occasions during the past ten years, iris rhizomes attacked by a species of *Botrytis*, have been intercepted by inspectors of the U. S. D. A. Plant Quarantine and Control Administration in shipments from France, Germany, England, and Holland. Some of these specimens were submitted to the senior author for examination at the time of interception. Others have been kindly loaned to us by Dr. J. A. Stevenson of the Office of Mycology and Plant Diseases. In addition to these records, the senior author has had affected plants under observation since May 1924 in an iris plantation at Ithaca, N. Y. In June 1927 the junior author found an iris infected by the same fungus in a nursery near Ottawa, Ontario. In January 1931 Dr. Freeman Weiss sent us, from Washington, D. C., some diseased iris rhizomes taken from three shipments grown in the state of Washington. These were covered with the same *Botrytis*. Subsequently, after a visit to the Washington State plantation, Dr. Weiss, in a letter, describes the disease as very destructive, the greater part of the planting of at least two or three acres having been severely affected.

In view of the widespread and serious nature of the disease, it seems desirable to publish a preliminary account, describing and naming the fungus involved. The only published reference to this fungus known to us is a short note by the junior author on its occurrence in Ontario, accompanied by a photograph of a diseased [MYCOLOGIA for September-October (24: 421-468) was issued September 1,

1932]

rhizome.<sup>1</sup> In the cases thus far observed the fungus has been confined to varieties of the garden iris derived from the species *I. germanica*, *I. pallida*, and *I. plicata*.

#### PATHOGENY

The names "rhizome rot" and "crown rot," either of which might be applied to the disease caused by this fungus, are used fairly generally for the diseases of rhizomatous iris caused by *Bacillus carotovorus* Jones and *Sclerotium Delphinii* Welch, respectively. The one here described will be referred to as the "*Botrytis* rhizome rot."

Affected plants either fail to develop new leaves in the spring or a few shoots may appear which later turn yellow and finally die by midsummer. On the exposed portions of the rhizomes and at the bases of the leaf sheaths of the previous year's growth, in fact often involving the entire shoot, a dense short felt of dark grey to purplish-brown conidiophores and conidia of the *Botrytis* develop very early in the spring. On the surface of the rhizomes or breaking through the epidermis among the conidiophores and in the soil among the dead roots are agglomerations of characteristically convolute, shiny black sclerotia (PLATE 15, FIG. 1). The plant is easily removed from the soil because of the death and decay of the roots. The rhizomes are shrivelled and partially or completely decayed; the diseased flesh is grey-brown in color, essentially dry and pithy in texture, with distinct rifts in the disintegrating tissues. In partially affected rhizomes, distinct zones of decay may be noted, with a darker colored band sharply delimiting the diseased from the healthy tissue. No disagreeable odor accompanies this decay.

The causal relation of the *Botrytis* to the lesions with which it is constantly associated is hardly to be questioned. The pathogenicity of the fungus has been proven by repeated inoculation of healthy rhizomes in moist chambers in the laboratory. Freshly divided rhizomes of three varieties of iris were inoculated with cultures of six isolates growing on wheat, when planted in the field on November 4, 1931. The following April, all the inoculated plants were dead and covered with sclerotia and conidiophores of

<sup>1</sup> Drayton, F. L. In Report of the Dominion Botanist. Dominion of Canada. Department of Agriculture 1927: 22-23, fig. 1.

the pathogene. The check plants were perfectly sound. Infection apparently occurs only when the inoculum is introduced into wounds, and is most prompt and extensive at 12°–18° C. At 20°–22° C. invasion is quickly restricted by the formation of a wound periderm about the lesion.

Just when and how invasion occurs in the field remains to be discovered. All the evidence available points to entrance through wounds of one kind or another, with pathogenic activity occurring only during autumn, winter, and early spring. A detailed study of the disease including the life history of the pathogene is under way. This paper deals primarily with the morphology and description of the heretofore unnamed species of *Botrytis* which causes the disease.

#### CULTURAL CHARACTERS

Pure cultures of the fungus may be obtained readily on any of the common culture media from plantings of decayed tissue, sclerotia, or spores. Conidiophores, conidia, and the convolute sclerotia are promptly produced in such cultures.

The fungus in its cultural characters is very distinct from any other species of *Botrytis* with which the authors are familiar. The senior author has studied over one thousand isolates of *Botrytis* species from many hosts but has never seen another species markedly resembling this one. Several isolations of *Botrytis* species of the cinerea type having been made from the leaves, and inflorescence of iris both in the United States and Europe, but this one attacking the rhizomes is quite distinct and could scarcely be confused with any of the others.

The sclerotia present the same convoluted agglomerated aspect on culture media as they do on the rhizomes. The conidia also tend to develop a more or less dense felty growth on culture media, similar to that on the host in nature. The optimum temperature for their production in culture is 20° C.

On potato dextrose agar <sup>2</sup> growth is rapid, giving a continuous mat of aërial white mycelium which later becomes buff colored. Conidia are usually produced in tufts or patches over the surface of the media, varying in abundance with conditions of light,

<sup>2</sup> 400 grams potatoes per liter of water, 2 per cent dextrose and 2 per cent agar.



temperature, and humidity. Sclerotia also vary in abundance from single ones 1–3 mm. in diameter up to agglomerations 16–18 mm. across.

Development on oatmeal agar<sup>3</sup> is vigorous and very similar to that on potato dextrose agar.

On Czapek's agar conidiophores cover the entire surface of the media in a dense short felt. Sclerotia are usually numerous but the agglomerations are smaller than on potato dextrose agar.

On nutrient agar, growth is slow, with no aërial mycelium. Neither conidia nor sclerotia have developed in our cultures on this medium. The submerged radiating mycelial mat exhibits an irregular wavy margin.

Abundant production of conidial fructification and sclerotia occur on bean plugs, steamed wheat, and on steamed stems of various succulent plants. (PLATE 16, FIG. 3.)

Appresoria develop in all culture media tested (except nutrient agar) wherever the aërial mycelium comes in contact with the glass sides of the culture vessel. These appresoria are typical of those formed by other species of *Botrytis* and *Sclerotinia*.

Microconidia are produced in great abundance, usually in four to six weeks in old cultures on potato dextrose agar.

#### MORPHOLOGY

The mycelium is much branched, hyaline, septate, 4.5–6  $\mu$  in diameter when young; the older hyphae are larger and more closely septate, definitely constricted at the septa, 6–7.5  $\mu$  in diameter, becoming tan colored.

The pale brown conidiophores arise in fascicles from dark, thick-walled, closely septate hyphae near the surface of the substratum (PLATE 16 FIG. 4) or from the sclerotia. They vary in height from 0.82 to 1.12 mm. and in diameter from 9–12  $\mu$  at their bases to 6–7.2  $\mu$  near the apices. Each conidiophore consists of a main axis, toward the apex of which are given off several short branches more or less extensively divaricate. The ultimate hyaline thin walled branchlets of the developing conidiophore are dichotomously forked, the tips swelling to form the "ampullae"<sup>4</sup> upon which numerous spiney sterigmata appear. The tips of

<sup>3</sup> 50 grams rolled oats per liter of water, agar 2 per cent.

<sup>4</sup> The term used by Klebahn in *Zeitschrift für Botanik* 23: 251–272. 1930.

the sterigmata rapidly swell to form the young conidia (TEXT FIG. 1). The short sterigmata on which these spores are borne are to be distinguished only before the conidia are full grown. When the spores are mature traces of the sterigmata are no longer to be discovered neither on the conidia nor on the collapsed ampullae.

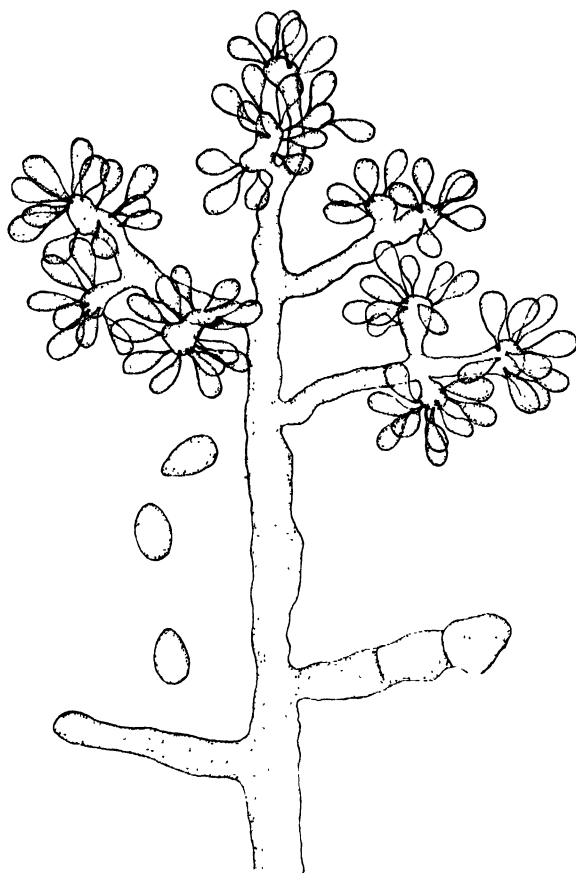


FIG. 1. A young conidiophore, showing the swollen terminal branches (ampullae) on which the conidia are borne. Mature conidia detached.

With maturity of the conidia the branchlets become septate, collapse, and drop away, leaving only the main axis with one or more of the main branches. The positions of the abscised branches and branchlets are marked by raised circular scars. The final collapse of the ampullae and branchlets appears to be due to

the drainage of their protoplasm into the maturing conidia. The conidia usually drop away singly, but one may frequently see in a mount, clusters of these spores still attached to a shrivelled terminal branchlet which has become detached.<sup>5</sup> Under favorable conditions of food and humidity proliferation of the conidiophores takes place, the new axis arising just laterally of the tip of the old one.

The mature conidia are light brown, ovate to slightly pyriform, unicellular although an occasional abnormal uniseptate individual is encountered. Their size is variable depending apparently on the type of substratum on which they are grown. The following records will illustrate this variability. In each case two hundred conidia mounted in water were measured. Specimen B1036 from freshly collected diseased rhizomes bore conidia having a range of  $7-18 \times 5.25-12.75 \mu$ , mode  $11.0-11.75 \times 9.0-9.75 \mu$  and averaging  $11.41 \times 9.25 \mu$ , compared with which cultures from this same collection grown on potato dextrose agar give conidia with a range of  $6.72-16.8 \times 5.04-11.76 \mu$ , a mode of  $10.08-11.76 \times 6.72-8.4 \mu$ , and averaging  $11.32 \times 7.61 \mu$ ; distinctly smaller it will be noted. Conidia from dry herbarium material of this same collection (B1036) gives a range of  $6.0-13.5 \times 4.75-10.0 \mu$ , a mode of  $10.0-10.75 \times 8.0-8.75 \mu$  and an average of  $9.05 \times 7.22 \mu$ , measurements as might be expected distinctly smaller than those of freshly collected living conidia. Conidia of another isolate (B927) growing on potato dextrose agar, Czapek's agar, and bean plugs, give measurements varying slightly from those of B1036 on potato dextrose agar as recorded above.

The sclerotia when mature are shining black, much convoluted to form more or less globose masses (PLATE 15 FIG. 2), which are frequently agglomerated in large clusters on the rotted rhizomes. They present the same aspect in cultures on all media rich in carbohydrates. A single convolute sclerotium may be as large as  $18 \times 16$  mm. although in general they average considerably smaller. When held for a time at low temperature and then

<sup>5</sup> The non-wettability of the conidia and conidiophores of *Botrytis* in water or glycerin makes it almost impossible to obtain satisfactory mounts for critical study in such mounting media. It was discovered that purified mineral oil (Nujol) is a perfect mounting medium for the conidiophore of *Botrytis* and similar fungi.

brought into a temperature of 20°–22° C. the sclerotia promptly germinate producing over their surfaces numerous tufts or fascicles of conidiophores with conidia. The convolute character of the sclerotia distinguishes this *Botrytis* from all the hundreds of forms we have had under observation during the past twenty years. It is because of its peculiar sclerotia that we designate this species as new.

Appresoria are typical of those produced by other *Botrytis* forms of the cinerea type.

The microconidia which have been observed as yet only in pure cultures, undoubtedly occur in nature and presumably function as fertilizing sperms in the production of as yet unobserved apothecial fruit bodies of the *Sclerotinia* type, just as the junior author has already shown to be the function of the microconidia in *Sclerotium Gladioli* Massey.<sup>6</sup> They are globose, hyaline, 2.5–4.5  $\mu$  in diameter, produced on typical fasciculate conidiophores arising from single cells in the hyphae about the bases of conidiophores or on the sclerotia (PLATE 16 FIG. 5). They are produced in the greatest abundance in this species appearing as viscous turbid droplets varying in size from a pin point to a millimeter in diameter.

#### TECHNICAL DESCRIPTION

##### ***Botrytis convoluta* sp. nov.**

Mycelium profusely branching, septate, hyaline, becoming tan colored with age at surface of the substrate. Sclerotia shining black, convolute, agglomerated, up to 18  $\times$  16 mm. in size. Conidiophores brown, erect, fasciculate, branched at the apex, about 1 mm. tall, 9–12  $\mu$  in diameter at the base, tapering toward the apex, arising from large dark thick-walled cells in the mycelium or from medullary cells just beneath the rind of the sclerotia. Conidia light brown, one-celled, smooth, ovate to slightly pyriform, borne in dense clusters on sterigmata produced from the swollen ampullae of the ultimate branchlets of the conidiophores; size variable, living spores from diseased rhizomes range from 7–18  $\times$  5.25–12.75  $\mu$ , mode 11.0–11.75  $\times$  9.0–9.75  $\mu$ , average 11.41  $\times$  9.25  $\mu$ ; somewhat smaller when produced on culture media.

<sup>6</sup> Drayton, F. L., *Mycologia* 24: 345–348. 1932.

Microconidia globose 2.5–4.5  $\mu$  in diameter, produced successively from the tips of obclavate conidiophores, arising in densely branched fascicles from single large globose or obovate hyphal cells of the mycelium or from the sclerotial medulla.

Sclerotiis atro-nitentibus convolutis agglutinatibus, usque ad 18  $\times$  16 mm.; conidiophoris brunneis, erectis, fasciculatis apice ramosis, circa 1 mm. altis, e cellulis callosis mycelii aut e sclerotiis orientibus; conidiis pallide brunneis, ovatis vel pyriformibus, 7–18  $\mu$  longis, 5.25–12.75  $\mu$  diam.; microconidiis globosis 2.5–4.5  $\mu$  diam.

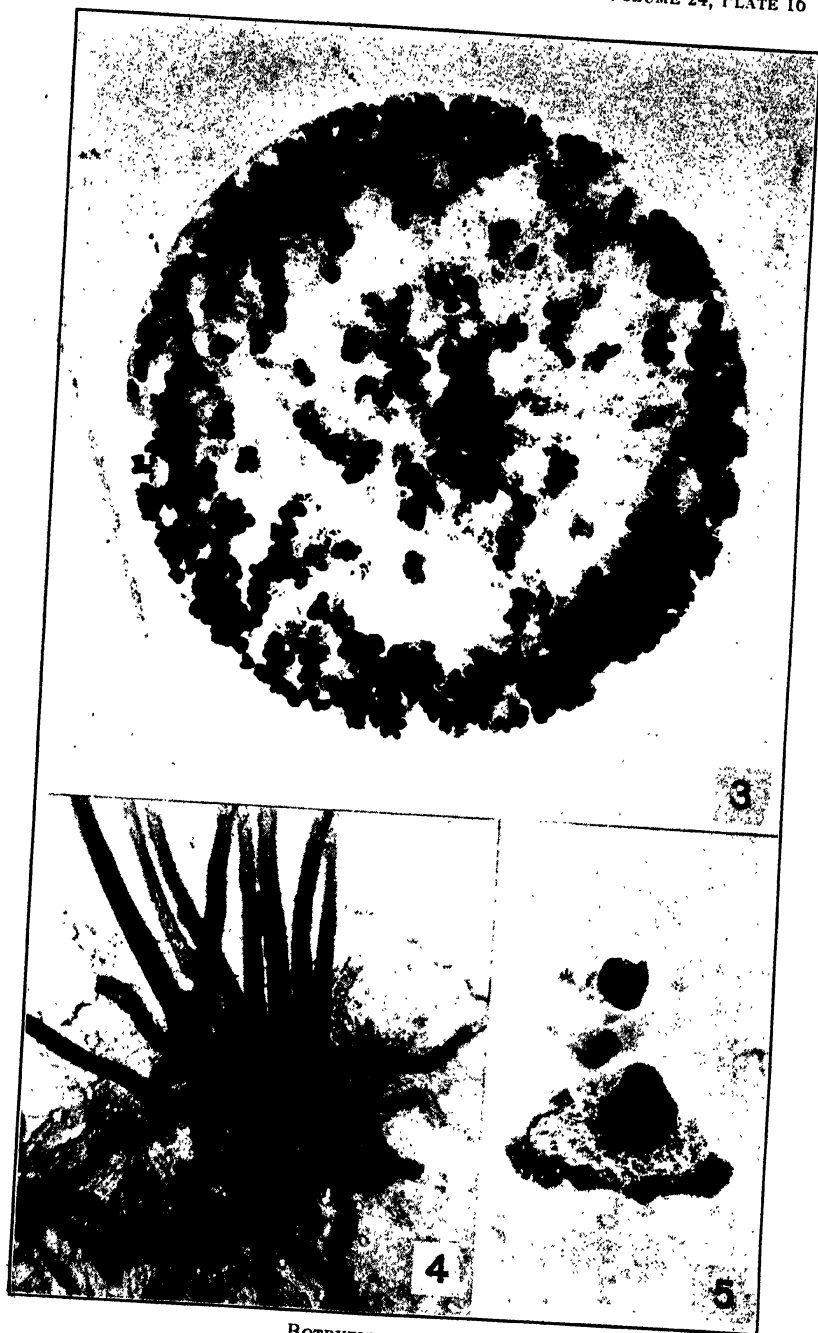
Parasitic on rhizomes of species of rhizomatous Iris. To be found in early spring (March and April). Known from Germany, France, Holland, England, United States and Canada. Type specimen deposited in Plant Pathological Herbarium Cornell University, Ithaca, N. Y. No. 12615.

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ITHACA, NEW YORK

#### EXPLANATION OF PLATES

Plate 15, Fig. 1. A diseased iris plant. The leaves are decayed, the rhizome shrivelled, the roots decayed, masses of sclerotia and conidiophores arising from the tissues; Fig. 2. Sclerotial agglomerations enlarged 5 $\times$ .

Plate 16, Fig. 3. A petri dish culture on sterilized wheat; Fig. 4, Conidiophores arising from large hyphal cells; Fig. 5, Sclerotia with attached microconidial sporodochia.



*BOTRYTIS CONVOLUTA*



# THREE NEW SPECIES OF MYTILIDION IN THE PROPOSED SUBGENUS, LOPHIOPSIS<sup>1</sup>

M. L. LOHMAN

(WITH PLATE 17 AND 1 TEXT FIGURE)

The species of hysteriaceous fungi described in this paper as new are worthy of special note; not so much in that their slender asci and sinuous spores segregate them from known species of *Mytilidion* to a degree which, in the opinion of the writer, is properly emphasized in the establishment of the new subgenus *Lophiopsis*, but rather in that they connect more closely the heretofore somewhat isolated genus *Lophium*, with the genera of those species which have more truly hysteriform fructifications. As transitional forms their diagnostic features are those which might have been assumed; namely, (1) thin-walled, carbonaceous, conchiform hysterothecia typical of the species of both *Lophium* and *Mytilidion*, (2) subcylindrical or cylindrical asci as known in species of *Lophium*, and (3) colored ascospores (of the form commonly termed scolecosporous) which are more elongate than those known for *Mytilidion* but which, as in species of *Mytilidion*, do not exceed in their length half that of the ascus, presenting, therefore, a more or less biseriate arrangement in the ascus as opposed to the fasciculate grouping of the spores in the lino-sporous genus, *Lophium*. Thus, it is upon the basis of the length of the ascospore, relative to that of the ascus, that the species are referred to *Mytilidion* rather than to *Lophium*, and upon the basis of the ratio of length of spore to breadth of spore that the subgenus *Lophiopsis* is proposed to receive them. Two of the three species are now being cultivated. The color, rate of growth, and nature of their mycelia (as compared with the mycelial characteristics of a number of species of *Mytilidion* and of *Lophium mytilinum* (Pers.) Fries and *L. dolabriforme* Wallr.) support this disposition of the three species.

<sup>1</sup> Contribution No. 109 from the Laboratories of Cryptogamic Botany Harvard University.



A study of the following emendation will reveal that the reference of these species to the genus *Mytilidion*, established by Duby (2) in 1861, necessitates no grave alteration of our concept of the genus other than extending somewhat the limits of the characteristics of the ascospore.

MYTILIDION Duby (*l. c.*, *sub nom. Mytilinidion*), emended

Hysterothecia superficial, prosenchymatous, fragile-carbonaceous, sessile and erect with the lateral walls more or less connivent and extended vertically. Asci 8-spored, clavate to subcylindric. Ascospores colored, elliptic-oblong to fusiform or (in the subgenus *Lophiopsis*) elongate-fusiform to slender-clavate, with three or more septa.

MYTILIDION Duby, emend.—Hysterothecia superficialia, prosenchymatica, fragilia carbonacea, sessilia, verticalia, labiis plerumque acutis arte conniventibus. Asci octospori, clavati vel subcylindrici. Sporidia flavescentia, aut elliptico-oblonga aut (in subg. *Lophiopsis*) elongato clavulata, 3- — pluri-septata.

#### SUBGENUS I. EU-MYTILIDION

*Spores clear yellow-brown to fuscous, with a ratio of length to breadth of approximately 10 : 1 or less.*

In this subgenus (which is the genus *Mytilidion* of most authors) there is correlated with the ratio of measurements—a factor of practical taxonomic value—the phenomenon of polarity in germination, *i.e.*, the terminal cells of the spore germinate first, and often only these cells germinate: This additional factor is authenticated by the writer's studies (3) concerning germinating spores in the species, *M. tortile* (Schw.) Sacc. and *M. laeviusculum* (Karst.) Sacc., in American specimens referred with considerable doubt to *M. decipiens* (Karst.) Sacc., and in a species being described elsewhere (4) as new.

#### SPECIES KNOWN TO OCCUR IN THE CENTRAL AND EASTERN STATES

Although extraneous to this paper in view of its title, the following notes on species known to occur in the central and eastern states are given, since, in concerning species probably not uncommon in this country on the bark or wood of conifers, they may be helpful to those who attempt a systematic study of this genus.

*Mytilidion tortile* (Schw.) Sacc. is a well-defined species in this country, as Bisby (1) has concluded. In view of the discrepancies in the various descriptions under this name, the writer is presenting elsewhere (4) a rather detailed diagnosis of the species, based upon his observations of the fungus in culture and upon his study of *Hysserium tortile* Schw. (2065 in the herbarium of Schweinitz at Philadelphia).

*Mytilidion Karstenii* Sacc. (as originally described by Karsten) with spores  $38-49 \times 4-4.5 \mu$ , only slightly tapered to the truncate upper end, has been collected in New England from the bark of *Pinus*, while *M. laeviusculum* (Karst.) Sacc. (as described by Karsten; cf. 4) has been collected in Michigan from unexposed surfaces of the wood of *Larix*.

*Hysserium Thujarum* Cooke & Peck, for which Bisby (1) has described reasonably authentic material, is a good species and one which, in the opinion of the writer (see 4), is more properly considered as of the genus *Mytilidion*. The species appears to be common in northern Michigan and Wisconsin, at least where cut-over stands of *Thuja* are encountered. Collections which have come from this area indicate that the species is as variable in its morphology, and thus as perturbing to the student, as is either *Hysserium insidens* Schw. or *Hysserographium Mori* (Schw.) Rehm.

For *Mytilidion Karstenii* and *M. laeviusculum*, species mentioned above, and for *M. decipiens* (Karst.) Sacc. and *M. fusisporum* (Cooke) Sacc., species that have been reported as occurring in these regions, no critical notes based upon truly authentic material are available.

## SUBGENUS II. LOPHIOPSIS

*Spores yellowish to yellow-brown, with a ratio of length to breadth of approximately 20 : 1.*

In this subgenus there is correlated with the ratio of measurements of the ascospore a condition of non-polarity in germination, i.e., any cell of the spore may be the first to germinate (as in *Lophium mytilinum* (Pers.) Fries, cf. 3). It is proposed for an adequate disposition of the three following species.

**Mytilidion scolecosporum** Lohman, sp. nov. FIGURE 1, C.  
PLATE 17, A

Syn: *Septonema toruloideum* Cooke & Ellis, Grevillea 7: 6. 1878<sup>2</sup>

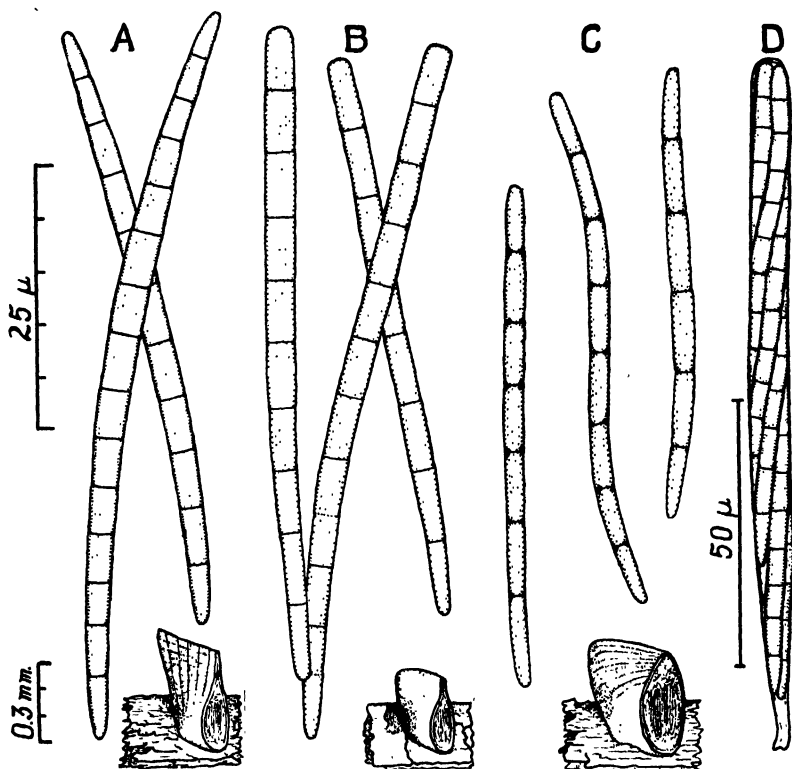


FIG. 1. Illustrating the features of the ascospores (approximate magnification  $\times 1335$ ) and the hysterothecia (approximate magnification of the halved fructifications, sketched in perspective,  $\times 33$ ) for *Mytilidion australe* (A), *M. parvulum* (B), and *M. scolecosporum* (C); also, the form of the asci and arrangement of the spores, as shown in D for *M. parvulum* (approximate magnification  $\times 665$ ).

Hysterothecia conchiform but not acutely keeled, densely gregarious, 0.4–0.8 (1)  $\times$  0.2–0.3 mm. (0.2–0.4 mm. in height), dull black and longitudinally striate, occasionally three-radiate and erect, or in pairs and horizontally disposed, superficial from the beginning on an effused black crust made more prominent in places by the minute, punctiform centers of conidial sporulation; walls prosenchymatous, thin, carbonaceous and fragile; asci

<sup>2</sup> See next Mycologia.

subcylindric,  $100-130 \times 4-5.5 \mu$ ; paraphyses delicate, hyaline, septate, sparingly branched and interwoven above; spores  $40-50 \times 2-2.5 \mu$ , subvermiform, occasionally bent or subsigmoid, yellowish to clear brown, subspirally biseriate, 5- to 7-septate and slightly constricted at the septa; conidia elliptic-oblong, tapered apically, deep fuscous throughout or with one or two of the apical cells paler, 3- to 5-septate,  $14-18 (24) \times 4.5-5 (6) \mu$ , deeply constricted, arranged in erect or variously decumbent, simple or sparingly branched, easily broken chains 75 to  $200 \mu$  in length; pycnidia unknown.

On wood of much weathered stump of *Pinus Strobus* L., Green Bay, Wis., Sept. 7, 1930. Collected by A. H. Smith. Type specimen in the Farlow Herbarium at Harvard University and material from the type collection in the University of Michigan Herbarium.

**Mytilidion scolecosporum** Lohman, sp. nov.—hysterotheciis conchiformibus haud quaquam acute cristatis, interdum triradiatim partitis,  $0.4-0.8 (1) \text{ mm.}$  longis,  $0.2-0.3 \text{ mm.}$  latis,  $0.2-0.4 \text{ mm.}$  altis, dense gregariis, nigris, longitudinaliter striatis, prosenchymaticis, fragilibus carbonaceis, superficialibus, plerumque ad crustam atrofuscam status hyphomyceti dispositis; ascis subcylindricis, octosporis,  $100-130 \times 4-5.5 \mu$ ; paraphysibus filiformibus, tenellis, superne ramosis et intertextis; sporidiis  $40-50 \times 2-2.5 \mu$ , fortiter elongatis, tenuibus, leniter flexis, flavescentibus, subspiraliter distichis, 5- to 7-septatis, ad septa paulo constrictis; conidiis concatenatis, aut omnino fuscis aut luteolioribus ad apicem, (3) 5-septatis, constrictis,  $14-18 (24) \times 4.5-5 (6) \mu$ , catenis inordinatis,  $75-200 \mu$  longis, fragilibus, simplicibus ramosisve.

This species, distinct in its subvermiform spores, shows its relationship to the species of the preceding section through *M. Karstenii* Sacc., *M. rhenanum* Fuckel, and *M. Thujae* Feltig.

**Mytilidion parvulum** Lohman, sp. nov. FIGURE 1, B, D.

PLATE 17, B, C

Hysterothecia conchiform and acutely keeled, superficial, black and shining,  $0.3-0.5 \times 0.15-0.18 \text{ mm.}$  ( $0.2-0.3 \text{ mm.}$  in height), arranged in loose but widespread aggregations which blacken the substratum; walls prosenchymatous, thin, carbonaceous and fragile; asci subcylindric, 8-spored,  $120-130 (135) \times 6-7.5 \mu$ ; paraphyses sparse, delicate, hyaline, septate, sparingly branched and interwoven above; spores (48)  $54-62 (65) \times 2.7-3 \mu$ , slender clavate with the upper end broadly obtuse and the lower pointed, usually slightly bent in the lower half, yellowish brown, subspirally biseriate, 7- to 9-septate (or becoming 11-septate by less distinct walls through several of the cells) and unconstricted.

On bark and wood of old stump (*Pinus*), Sharon, Mass., Dec. 5, 1908. Collected by A. P. D. Piquet. Type specimen in the Farlow Herbarium at Harvard University.<sup>3</sup>

**Mytilidion parvulum** Lohman, sp. nov.—hysterotheciis conchiformibus, superficialibus, atribus nitidisque, 0.3–0.5 mm. longis, 0.15–0.18 mm. latis, 0.2–0.3 mm. altis, laxe gregariis, prosenchymaticis, fragilibus carbonaceis; ascis subcylindratis, octosporis, 120–130 (135)  $\times$  6–7.5  $\mu$ ; paraphysibus sparsis, filiformibus, tenellis, superne ramosis et intertextis; sporidiis (48) 54–62 (65)  $\times$  2.7–3  $\mu$ , valde elongatis, clavulatis, plerumque in deorsam semipartem leniter flexis, flavidis luteofuscisve, subspiraliter distichis, inconstictis, aut 7–9-septatis aut ullo loculo etiam indistincte partito, quo 11-septatis.

Although its fructifications are small, as the specific name implies, the species has longer spores than does either *M. scolecosporum* or *M. Karstenii*. Hence, it approaches *Lophium mytilinum* more closely than does either of the two species just mentioned.

**Mytilidion australe** Lohman, sp. nov. FIGURE 1, A.  
PLATE 17, D–F

Hysterothecia vertically appressed with fan-shaped crests, densely aggregated in small scattered clusters, 0.4–0.6 (0.8)  $\times$  0.15–0.2 mm. (0.3–0.4 mm. in height), vertically and longitudinally striate, black and shining; walls prosenchymatous, thin, carbonaceous and fragile; asci subcylindric, 8-spored, 125–150  $\times$  8–9  $\mu$ ; paraphyses sparse, delicate, hyaline, septate, branched and interwoven above; spores (54) 58–70 (75)  $\times$  3–4  $\mu$ , elongate, tapered equally toward each end, slightly curved to sublunate, yellowish, subspiraliter biseriate, (10) 11- to 14-septate and unconsticted.

On much decayed wood of *Pinus*, Baton Rouge, La., Dec. 27, 1931. Collected by A. H. Smith. Type specimen in the Farlow Herbarium at Harvard University and material from the type collection in the University of Michigan Herbarium.

**Mytilidion australe** Lohman, sp. nov.—hysterotheciis conchiformibus, pertenuibus, quasi flabelliformibus, densis in greges parvos sparsos, 0.4–0.6 (0.8) mm. longis, 0.15–0.2 mm. latis, 0.3–0.4 mm. altis, verticaliter ac longitudinaliter striatis, atribus, nitidis, prosenchymaticis, fragilibus carbonaceis; ascis subcylindratis, octosporis, 125–150  $\times$  8–9  $\mu$ ; paraphysibus sparsis, filiformibus, tenellulis, superne ramosis et intertextis; sporidiis (54) 58–70 (75)  $\times$  3–4  $\mu$ , elongatis, leniter flexis sublunatisve, flavescentibus, subspiraliter distichis, (10) 11- quoad 14-septatisve, inconstictis.

<sup>3</sup> Dr. Farlow had studied the specimens of this collection and had noted that they represented an undescribed species of *Mytilidion*.

Since there is no black fungous layer present, the rather scattered, slender fructifications on the weathered wood are scarcely noticeable to the unaided eye. The long, slightly curved spores with many septa could not be confused with those of any known species of the genus.

#### CONCLUDING REMARKS

Although at the present time each of the three foregoing species is known to occur only on *Pinus* and at the respective station indicated in its description, the species undoubtedly occur elsewhere and possibly on conifers other than *Pinus*. The habits of *Lophium mytilinum* and certain species of *Mytilidion* lead one to believe that *M. scolecosporum* and *M. australe* are likely to be encountered on bark as well as on decayed wood. However, since certain *Mytilidion*-like species show a specificity to a single generic coniferous substrate, special effort should be made to identify the wood or bark in recording the occurrence of these fungi.

Differing from *Lophium mytilinum* in the ratio of length to breadth of the ascospore and in the arrangement of the spores in the ascus although resembling that species in the method of germination of the ascospore, these species are referred to the new subgenus, *Lophiopsis*, proposed as a segregation of *Mytilidion*. Intermediate with respect to certain diagnostic features between *Lophium* and *Mytilidion* as conceived by earlier students of the Hysteriaceae, these species constitute a significant step in advance in our knowledge of the interspecific relationships of those hysteriaceous fungi which appear to be more or less confined to coniferous substrata.

Two of the three species, namely, *Mytilidion scolecosporum* and *M. australe*, are being studied in culture in connection with further investigations into the life histories of members of the Hysteriaceae,—studies which are being pursued by the writer as a National Research Fellow under the sponsorship of Prof. William H. Weston, Jr.

NATIONAL RESEARCH FELLOW  
LABORATORIES OF CRYPTOGRAMIC BOTANY  
HARVARD UNIVERSITY

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2. Duby, J. E. Mémoire sur la Tribu des Hystérinées de la Famille des Hypoxylées (Pyrénomycètes). *Mém. Soc. Phys. d'Hist. Nat. Genève*. **16**: 15-71. 1861.
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4. Lohman, M. L. Hysteriaceae: Life histories of certain species. *Ibid.* (for 1932). In press.

## EXPLANATION OF PLATE 17

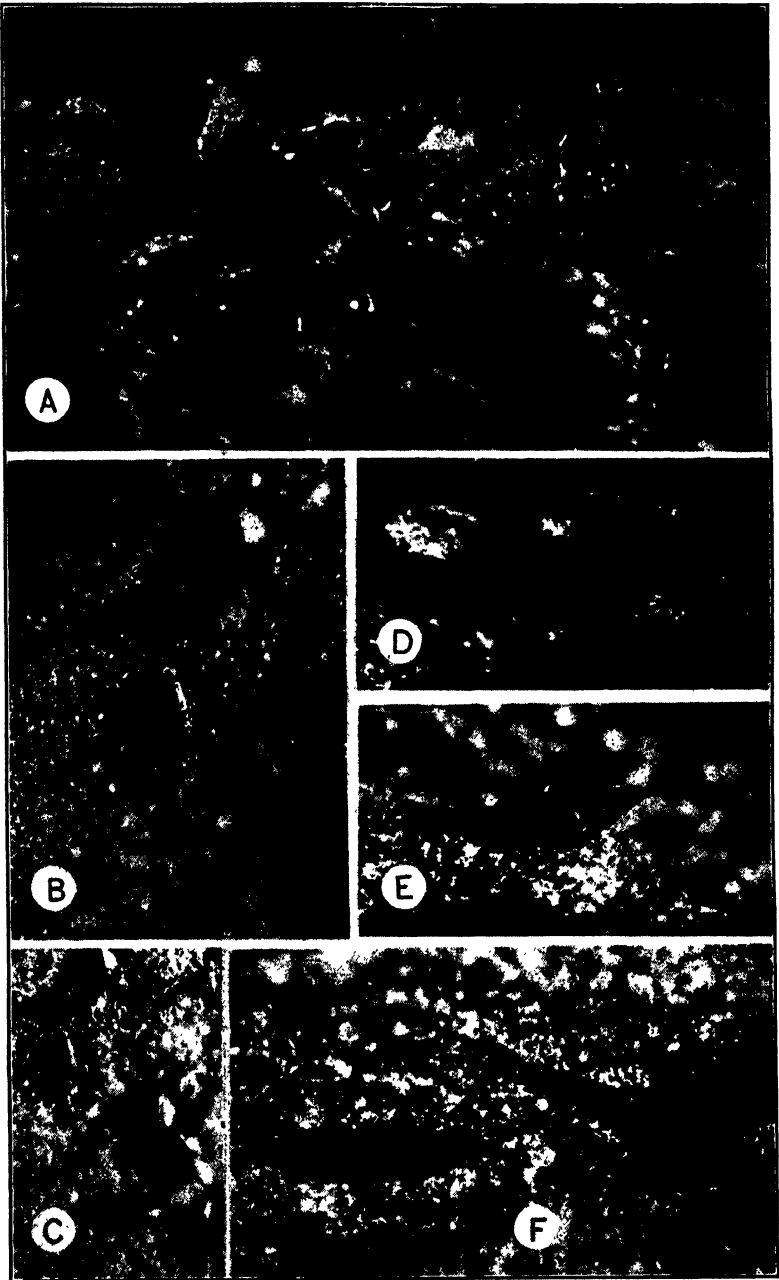
Hysterothecial habits of three new species of *Mytilidion*

The photographs illustrate portions of the type specimens for these species and as reproduced they represent an approximate magnification of 30  $\times$ , with the exception of *C*, which is  $\times 15$ . (One not especially familiar with *conchiform* fructifications should study in connection with the photographs the rather schematic drawings of halved fructifications shown in the text figure.)

*A. Mytilidion scolecosporum* on weathered wood of *Pinus*. The illustration includes about twenty fructifications surrounded and overlain in part by the effused conidial stage (*Septonema toruloideum* Cooke & Ellis). Centers of conidial sporulation are most evident near the left margin.

*B, C. Mytilidion parvulum* on bark from an old stump of *Pinus*. *B*, a group of seven fructifications, is an enlargement of the upper portion of *C*.

*D-F. Mytilidion australe* on decayed wood of *Pinus*. *D*, a small group of fructifications as viewed from the side; *E*, a single fructification as observed obliquely; *F*, a single fructification (in central, left portion) as seen from above and two fructifications (in right portion) as viewed laterally.



MYTILIDION





# IDENTIFICATION OF *DIAPORTHE UMBRINA* ON ROSE FROM ENGLAND <sup>1</sup>

ANNA E. JENKINS AND R. P. WHITE

(WITH PLATES 18 AND 19)

## INTRODUCTION

In November, 1931, a cankered rose-stem specimen from England was sent to the senior author by G. H. Pethybridge, Mycologist of the Ministry of Agriculture and Fisheries, Harpenden, Hertfordshire, to learn whether the fungus present might not be *Diaporthe umbrina* Jenkins. The specimen was collected at Cheltenham, Gloucestershire, in October, 1931 by L. Ogilvie, Advisory Mycologist at the Agricultural and Horticultural Research Station, Bristol. The fungus on this specimen is unquestionably what is called *Diaporthe umbrina* in the United States. It seems likely that the brown canker rose disease caused by this organism is not as prevalent in England as in the United States, or it would have been recognized earlier by its generally definite and conspicuous symptoms.

Identified as *Diaporthe umbrina*, this fungus, causing brown canker of roses, has not heretofore been reported from England or elsewhere than in the United States, although attempts have previously been made on the part of the senior author to learn whether it was of wider distribution. Together with certain other diseases, actual search for this disease was made in various rose plantings in continental Europe and in England and Scotland, in 1929-1930, by Cynthia Westcott, then Heckscher Research Assistant, Department of Plant Pathology, Cornell University, Ithaca, N. Y., and in 1930, in similar regions by the junior author, and in England and Scotland by the senior, who examined roses both growing wild and cultivated. Westcott saw what appeared to be brown canker in a certain rose garden in

<sup>1</sup> Joint contribution from the Division of Mycology and Disease Survey, Bureau of Plant Industry, United States Department of Agriculture and the Department of Plant Pathology, New Jersey Agricultural Experiment Station.

England, but otherwise no evidence of the occurrence of the disease resulted from this rather limited survey.

Since the identification of the Cheltenham fungus as *Diaporthe umbrina* constitutes the first knowledge of the occurrence in Europe of this important rose pathogene, the studies made in connection with the identification are here reported. This seems particularly advisable since they afford some additional data pertaining to the morphology, cultural characteristics and life history of the organism. As thus recorded these may be of further assistance in its recognition.

The appearance of the cankered stem was typical for brown canker, although from this rather meagre material (PLATE 18, A and B) positive diagnosis could not be made. The *Diaporthe* was present mostly in its perfect stage. Comparison of this stage (PLATE 19, A) with that of *Diaporthe umbrina* from Arlington Experiment Farm, Rosslyn, Va., showed these two stages to agree. It is known, however, that there is a *Diaporthe* on rose, undetermined specifically,<sup>2</sup> that closely resembles *D. umbrina* in its perfect stage, but differs from it in having a typical *Phomopsis* imperfect stage as well as in its cultural characteristics.

Under the circumstances, cultural and other studies of the Cheltenham fungus were made to be certain of its agreement with *Diaporthe umbrina* from the United States. PLATE 18, E, shows a 3-months-old, original isolation of the Cheltenham fungus growing on a potato-dextrose agar medium test-tube slant. The color of the conidial masses were here "cinnamon buff"<sup>3</sup> and that of the hyphal growth, "olive brown." From this isolation the fungus was inoculated on blooms and flower stalks of the hybrid tea rose, Lady Margaret Stewart, known to be highly susceptible to *D. umbrina*. In 3 days characteristic brown canker symptoms were produced on the blooms and in 12 days on the stalks, as shown in PLATE 18, C and D. The imperfect stage of the fungus was visible on the petals, as minute brownish

<sup>2</sup> Diseases of fruit and nut crops in the United States. United States Department of Agriculture Plant Disease Reporter Supplement 39, May 1, 1925, p. 360.

<sup>3</sup> Color readings in this account are based on Ridgway, R. Color standards and color nomenclature, 43 p., illus. Washington, D. C., and most of them were made by J. Marion Shull.

to blackish dots (PLATE 18, *D*). This is entirely characteristic of this stage of *D. umbrina*, which often grows on rose petals in the United States. The re-isolated organism was in agreement with the Cheltenham strain.

Culturally, the Cheltenham fungus was compared with two different isolations of *Diaporthe umbrina* from Arlington Experiment Farm, one of 1923 and the other of 1931, but both of essentially the same appearance. Such cultures on test-tube slants of agar media, potato-dextrose (PLATE 18, *F* and *G*) and corn-meal (PLATE 18, *II* and *I*), and on corn-meal agar media in Petri dishes (PLATE 19, *B* and *D*) are here represented. PLATE 18, *F* and *II*, and PLATE 19, *B*, represent the strain from England; PLATE 18, *G* and *I*, and PLATE 19, *D*, that from the United States, isolated in 1931. As illustrated, the two fungi are in agreement culturally, although they do show slight strain differences. These differences are not uncommon among different isolations of *D. umbrina* from the United States. Perhaps the most notable difference between the English and American cultures here compared is that, in mass, conidia in the culture from England usually differ in color from those of the American cultures. For example, at the time they were photographed, the conidial masses in the Cheltenham cultures shown in PLATE 18, *F*, were "deep olive buff" while those of the corresponding American culture shown in PLATE 18, *G*, ranged from "cream buff" to "chamois." In another instance, wherein the Cheltenham strain and the American isolation of 1923 were compared on oatmeal agar test-tube slants, the conidial masses in the former strain were "antimony yellow" to "yellow ochre" and those in the latter, "chamois." Grown on sterilized corn-meal media in Erlenmeyer flasks the Cheltenham culture was again characteristic of *Diaporthe umbrina* as known in the United States, although the coloration of its spore masses was somewhat different from that of the American strain compared with it.

Conidia, conidiophores, and hyphae of the Cheltenham fungus were in agreement with those of *Diaporthe umbrina*. Comparisons of conidia and conidiophores were made mostly on the basis of this stage as produced in culture and as developed on rose petals. Those of the hyphae were based largely on the hyphal

development at the margins of the cultures illustrated in PLATE 19, *B* and *D* (PLATE 19, *C* and *E*).

The data here presented show that, although there are slight cultural differences, the Cheltenham fungus, is to be considered identical with *Diaporthe umbrina*, previously reported only from the United States.

#### EXPLANATION OF PLATES

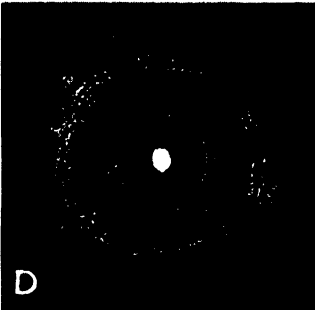
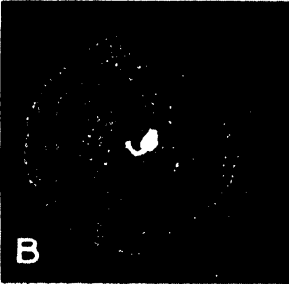
Plate 18. *Diaporthe umbrina*. *A*, specimen sent by G. H. Pethybridge, this having been collected at Cheltenham, Gloucestershire, England, October, 1931, by L. Ogilvie ( $\times 1$ ). *B*, enlargement of *A*, to show perfect stage fructifications of the fungus ( $\times 4$ ). *C* and *D*, rose leaf stalk (*C*) and bloom (*D*) inoculated with culture isolated from Cheltenham fungus, pycnidial stage showing as small dots on petals (*C*,  $\times 2$ ; *D*,  $\times 1$ ). *E*, 3-months-old slant culture on potato-dextrose agar medium, this being the original isolation from the Cheltenham strain ( $\times 1$ ). *F-I*, comparisons of the Cheltenham strain (*F* and *H*) with one of the American strains (*G* and *I*) on 10-day-old slant cultures of potato-dextrose (*F* and *G*), and corn-meal agar media (*H* and *I*) ( $\times 1$ ). Illustrations by M. L. F. Foubert.

Plate 19. *Diaporthe umbrina*. *A*, perithecium from Cheltenham specimen; *a* and *b*, asci; *c*, imperfect stage of fungus at side of perithecium; *d*, beak of perithecium protruding beyond surface of stem ( $\times 200$ ). *B*, week-old, corn-meal agar Petri dish culture of Cheltenham strain (*B*), grown in parallel with a strain from the United States (*D*) ( $\times 1$ ). *C*, hyphae at margin of *B*; *E*, at margin of *D* ( $\times 120$ ). Illustrations by M. L. F. Foubert.



*DIAPORTHE UMBRINA*





DIAPORTHE UMBRINA





# A NEW PARASITIC PYTHIUM

WILLY HÖHNK

(WITH PLATE 20 AND 11 TEXT FIGURES)

This fungus was obtained from a soil sample<sup>1</sup> in association with *Allomyces*. Its more rapid and vigorous growth hindered and at times completely suffocated the *Allomyces*. In the ice-box at a temperature of about 3° C., *Allomyces* grew slowly but at a fair rate of speed on agar<sup>2</sup> cultures while the *Pythium* grew very slowly or not at all. However, if the petri-dish cultures were kept at room temperature the *Pythium* would grow so rapidly as to smother the *Allomyces*. Because of this variation in growth it was possible to secure pure *Allomyces* at the lower temperatures and pure *Pythium* at the higher temperatures. The pure cultures of the *Pythium* were obtained by cutting out a small portion of agar at the edge of the colony grown under room temperature and transferring the piece to sterile water. After further growth had been established a single sporangium was carried over to a petri-dish containing sterile agar. After 24 hours it would be possible to make further transfers from this growth.

Ant larvae and various seeds were used as a supply of food for the fungus. All were attacked by *Pythium epigynum*. However on ant larvae the hyphae grew longer by about 1–1.5 cm. and very early formed reproductive organs. On hemp seed the

<sup>1</sup> The soil-sample was taken from the surface at the waterline of a pond in a meadow near Milton, Wisc. No plants were present; the grass-cover began at a distance of about 3 m.

<sup>2</sup> The same agar as used for Saprolegniaceae. Its constitution: Within 1 L. distilled water.

8–10 g. agar

5 g. Carragen or if not available 5 g. agar more

0.5 g. Dextrose

0.05 g. Citric acid

0.0005 g.  $\text{KH}_2\text{PO}_4$

0.000025 g.  $\text{NH}_4\text{NO}_3$

0.000025 g.  $(\text{NH}_4)_2\text{SO}_4$

0.000025 g.  $\text{MgSO}_4$

} stock solution

hyphae were short and so closely interwoven that observation was difficult, consequently ant larvae have been used in carrying out these studies.

The temperature relations of the fungus are shown in the following graphs (FIG. 1, *a* and FIG. 1, *b*).

Into a petri-dish 10 cc. of nutrient-agar were placed. Each of these were then inoculated with 9-12 resting-sporangia of an eight week old water culture. Two dishes were then exposed at the same time, to each degree of temperature, and this was

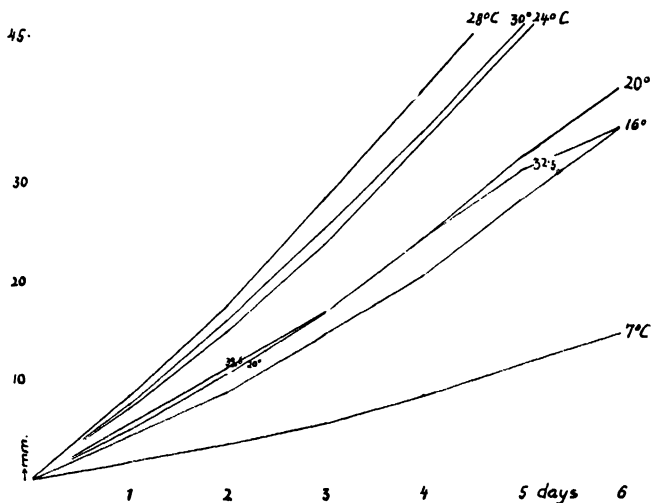


FIG. 1a. Length-growth during 6 days at different temperatures.

repeated twice or, if necessary, three times. The cultures were checked for contaminations and any showing impurity discarded and replaced by fresh cultures. The growth was generally circular and those which were not circular were discarded. They were measured daily in two diameters at right angles. Then the average was taken of all the 4 (or 6) cultures which had been grown for each degree of temperature. The average-diameters were divided by 2 in order to get the length of the radii and these are shown on graph 1a and 1b. Temperatures were checked daily. The variations were within 1.5° C.

The sporangia exposed to a temperature of 3.5° C. grew to about 300  $\mu$  within a day or two and then stopped. Curves at

7°, 16°, 20°, 24°, 28° and 30° C. are nearly straight (FIG. 1a). At all of these temperatures the daily growth equalled, and usually slightly exceeded the first day-rate of growth.—The optimum temperature is close to 28° C. At 30° C. and 24° C. the rates of growth are alike, as they are also at 20° C. and 32.5° C. (FIG. 1a), but between the latter two temperatures the lines cross. This point was checked three times with the same result. After three or four days the day-rates at 32.5° C. decreased and the mycelium failed to grow to the edge of the dish. The same occurred at a temperature of 3.5° C., but the duration of growth was only about one day. The same happened at a temperature of 36° C. But at 40° C. no germination or growth occurred and these cultures exposed for 4 or 5 days to a favorable temperature of 28° C. or lower remained sterile. The sharp descent of the curves between 28° C. and 35° C. is remarkable.

#### MYCELIUM

Recently infected ant larvae were surrounded by a web of hyphae at the end of 12–14 hours and the first sporangia were apparent at 24 hours. The main hyphae are branched and of a fairly uniform diameter, about 6  $\mu$ . As they elongate the basal portion thickens somewhat, often reaching a diameter of 8  $\mu$ . These main hyphae and their oldest broad branches dominate in the turf formed around the ant larva. A culture, left undisturbed for a week, shows the same strict radial growth as in many of the Saprolegniaceae, having thick hyphae. A characteristic type of growth is shown in figure 2. The side branches near the base are the largest and branches are more delicate as one approaches the tip of the main hypha. The same is true of the branches as well. Oftentimes the portion of a hyphae below an intercalary zoösporangium is thicker than the upper portion. This can be repeatedly found and is a result of the mode of formation as will be explained later. The expression “gradually getting thinner” on page 505 in the table of comparison has reference to this peculiarity.—The tips of hyphae are greatly attenuated. The number of lateral branches in a water culture are dependent upon the food available and not upon the amount of water present. If a fresh ant larva is placed close to one

already infected, the branching becomes very profuse and at the same time very irregular.

Within old hyphae (in a medium poor in food and after 3 days), irregular formation of cross walls may be found and these are more frequent in the thin side branches than in the heavy main hyphae.

#### SPORANGIA AND GEMMAE

The first formed zoösporangia are spherical or slightly oval in shape, usually intercalary, seldom terminal. The spherical zoösporangia average  $\pm 29 \mu$  ( $21-34 \mu$ ), the oval sporangia aver-

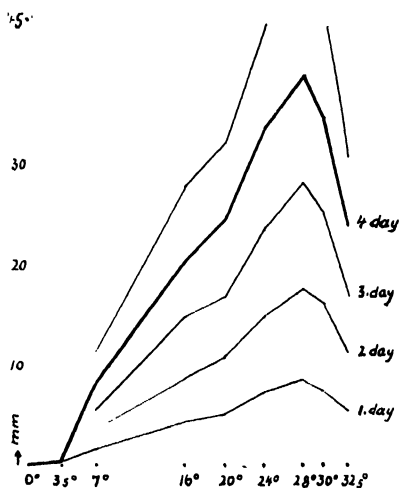


FIG. 1b. The curves show the daily growths at different temperatures.

age  $19-24 \mu$ :  $22-29 \mu$ . Some immediately form zoöspores, while most become resting-sporangia. Those which function immediately push out a long tube (about two times the sporangium diameter), frequently  $12 \mu$  in diameter as shown in figure 3. With the development of the tube, a vacuole makes its appearance within the protoplast and increases in size as the protoplast enters the tube and moves into the developing vesicle. The formation of zoöspores and their movement soon brings about a rupture of the vesicle.

Each zoöspore has two lateral cilia and a definite contractile vacuole. Under high magnification the operation of this vacuole

can be readily observed. The time between contraction and expansion becomes longer as the zoöspore matures. The swarm-period of the zoöspores varies from 10–25 minutes. At the end of the swarm-period the zoöspore becomes spherical; cilia and vacuole disappear and a surrounding membrane is soon formed. If fresh water is now added a second swarm period is noted after five hours. The protoplast leaves the membrane as a zoöspore of the same size and shape, with two cilia and a vacuole. Such a spore again undergoes a resting-period before germination.

As said, only a few of the first sporangia undergo sporulation at once. The others become resting sporangia. The same situation holds with reference to the later formed sporangia, only here still fewer of the sporangia germinate at once. The percentage of those which germinate immediately may be influenced by the addition of fresh water to the culture within 4–6 hours. These peculiarities indicate that the terms “primary” and “secondary” sporangia are unfortunate, even misleading. These terms have only descriptive value in describing members of the Prolifera-group of the Pythiaceae and certain genera of the Saprolegniaceae. Here are applied zoösporangia or “sporangia” and “resting sporangia” in order to indicate the possibilities of germination or sporulation later if influenced by increasing age or changes in environment.

A terminal sporangium is shown in figure 3, *a*. The swelling at the tip of the hypha is cut off by a cross-wall. An emptied cell is shown in figure 3, *b*. Others may undergo a resting period. These sporangia may remain terminal (following 3, *a-c-b*) or during the resting period a new hypha may be formed at the tip. It is interesting to note that only a portion of the protoplast of sporangium enters the young hypha which is now cut off by a new cross wall. The result is that the sporangium now becomes intercalary. This is shown in figure 3, *a-c-c<sub>2</sub>*. The transition from *c* to *c<sub>2</sub>* took place in 6½ hours. The new upper hypha is less in diameter than the older portion and may continue to grow, to branch and to build new organs. The latter can be accomplished by a recapitulation of 3, *a-b* or 3, *a-c<sub>2</sub>* or it may occur as a possibility as arising from *d* in figure 3. The latter type may be more readily and more frequently observed.

First an intercalary swelling appears. Then, as shown in figure 3, *e* the upper cross wall is laid down, this differs only in minor details from the manner in which a terminal cell is formed, but

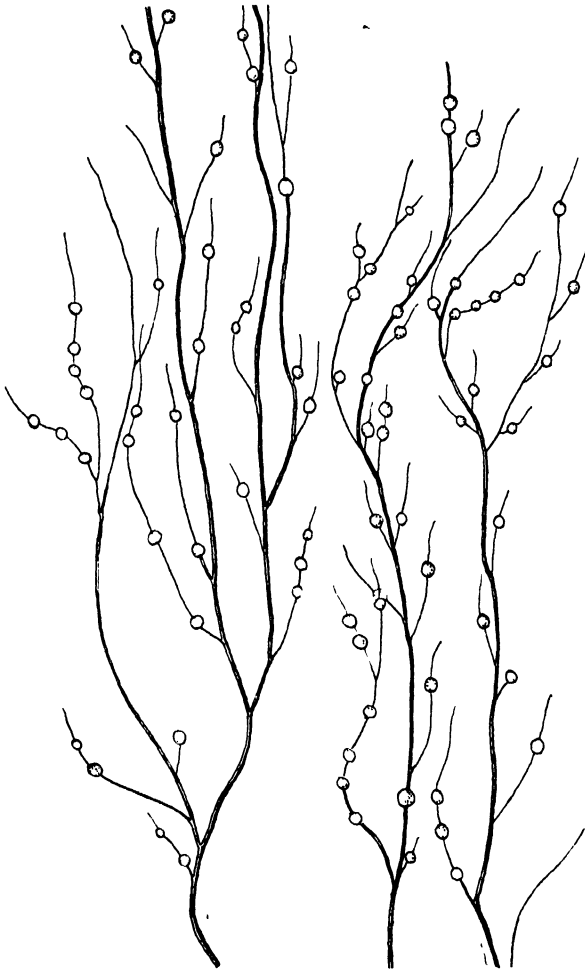


FIG. 2. Type of growth.

the intercalary cell is often oval in outline. There is a conspicuous movement of protoplasm from the part of the hypha below into this developing cell before the lower cross-wall is formed.

Both portions of the hypha, that above as well as that below the intercalary cell, may continue to develop other sporangia or to develop side branches. No branches were observed immediately

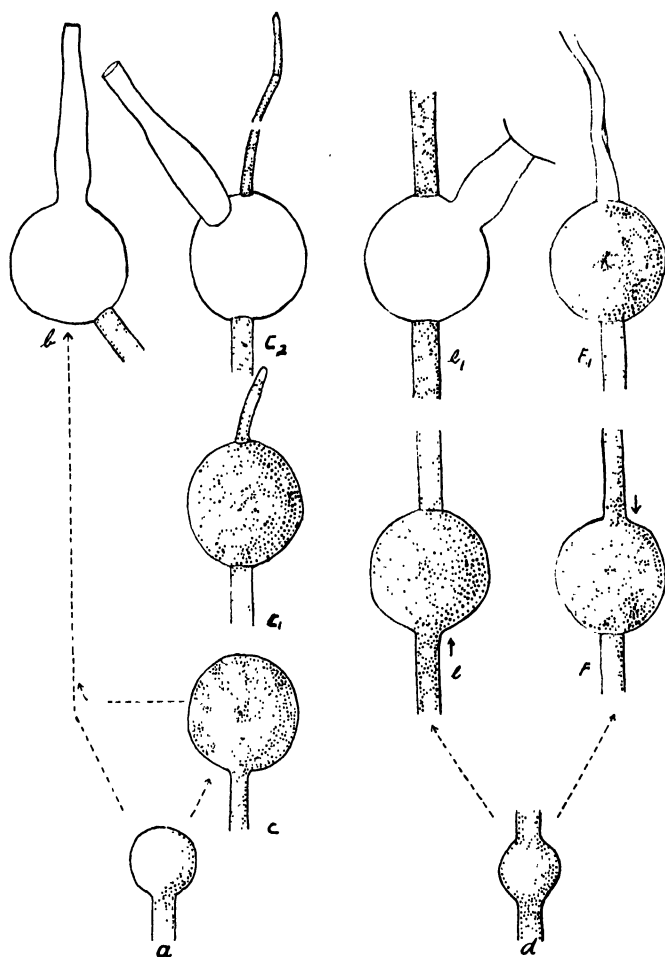


FIG. 3. Zoösporangium and resting-sporangium development. *b*, terminal sporangium. The development from *a-b* took at least 2 1/4 hours; *c-c2*, a terminal sporangium becomes an intercalary one. This drawn example *c-c2* took from 10:40 A. M.—4:30 P. M.; *e-e1*, an intercalary sporangium filled from below; *f-fi*, an intercalary one filled from above.

below the intercalary sporangium, although it is possible that such hyphae may be formed. The second mode of development shown in figure 3, *d-f* is observed if the lower wall is first formed.



The tip portion now empties its contents into the developing sporangium before the upper cross-wall is formed. This type of behavior has been observed only in the upper part of a hypha, at the margin of the fungal web.

These observations are not given in order to separate types but to explain the rarity of the terminal sporangia and to suggest that these modifications may account for the method of formation of the so-called "gemmae" whose behavior is the same as that of resting sporangia. The process of formation would be a modification of figure 3, *d-f*.

In older hyphae accumulation of protoplasts appeared. They varied greatly in their form as shown in figure 4, *a, b*, and *c*. These accumulations may take place in any portion of a hypha but they are more frequently found toward the tips. They are quite comparable to similar structures found among the Saprolegniaceae where they often occur in continuous rows. Here they are however most often found singly and not associated with oogones or sporangia. They are usually about 8-10 times the hypha diameter in length.

Butler (1907) with reference to Maurizio (1894), states that the gemmae among the Pythiaceae are not of the same value as those which are found among the Saprolegniaceae. The difference as stated by Maurizio,<sup>3</sup> is that the *Saprolegnia* gemmae are "sporangium anlagen," that is, they are a priori potential sporangia and later may germinate or sporulate. Butler denies this as the condition of the *Pythium* gemmae, "they are not of the same category." The following indicates the similarity of behavior of both resting-sporangia and gemmae.

The resting-sporangium of *Pythium* forms either zoöspores or germ-tubes. The older the resting-sporangium the less often does it produce zoöspores. After 6 weeks only rarely are zoöspores formed. A simple experiment readily illustrates this fact. To a turf of mycelium 6 weeks old which had been left undisturbed, an ant-larva was added. After two hours many

<sup>3</sup> Maurizio's paper of 1894, "Zur Entwicklungsgeschichte und Systematik der Saprolegnieen," Flora 109 pp. is meant, not that of 1896, "Die Sporangium-anlage der Gattung Saprolegnia," Jahrb. Wiss. Bot., p. 75 ff. and only so far as this single question is concerned. His terminology and the interpretation he gave (1896) cannot be accepted.

resting sporangia formed germ tubes (FIG. 4, *e*) but none formed zoöspores. The ant larva was removed and it was then noted that the germ-tubes formed new sporangia (FIG. 4, *d*). Some of these were placed in a water-mount in fresh filtered water for observation under the microscope. After 1 hour a few were already empty, in others zoöspores were being formed while by far the greater number remained as resting sporangia again. Now an ant larva was placed in the water mount at a distance of 1 cm. and in a short time germination occurred.

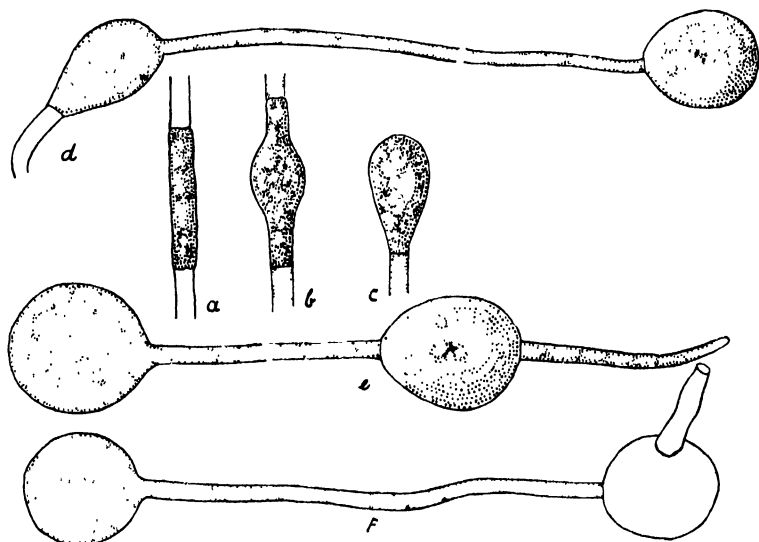


FIG. 4. *a*, *b*, and *c*, different forms of gemmae; *d*, germinating gemma produced a sporangium; *e*, an old germinating resting-sporangium produced a new intercalary resting-sporangium. *f*, an old resting-sporangium formed a sporulating sporangium.

This experiment was repeated for a further study of the behavior of the gemmae. They showed the same reactions. The old gemmae germinated and were able to form sporangia of regular shape, spherical or oval (FIG. 4, *d*). A few of these young sporangia developed from gemmae sporulated; the others became resting sporangia.

When the sporangia of regular forms were developed, thus using up the greatest part of the plasm, irregular plasm-accumulations appeared (like those shown in figure 4, *a*, *b*, and *c*) in

the longer germ-tubes of the resting-sporangia as well as in those of the gemmae.—At all times the sporangia, the resting sporangia and the gemmae showed the same behavior and therefore they can hardly be separated by means of different potential qualities.—Of interest is the question, whether the reduced ability of sporulation with increasing age is connected with cytological conditions.

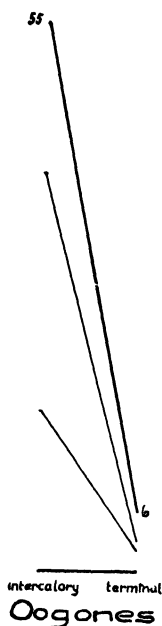


FIG. 5. Ratio for intercalary and terminal oögonia.

In view of the terminology of the vegetative propagation-organs of this species it can be said that the term sporangium could include the immediately sporulating sporangium as well as the resting-sporangium and the gemma. The first two kinds are developed during the vegetative period of the mycelium and show a regular form, while the gemmae appear at the end of the growth in length of the hyphae or later on and are therefore of irregular form. This is the only difference which might have recommended that sporangia and gemmae be spoken of separately.

Formations for which the term "chlamydospore" is again proposed by Rosenbaum (1915) and Dissmann (1927) did not occur.

#### SEXUAL REPRODUCTION

After 36 hours on ant-larvae, within a water-dish, sexual organs developed.

The formation of the oögone is very similar to that of an intercalary sporangium except that the diameter remains shorter. This formation is usually intercalary, very seldom terminal. Figure 5<sup>4</sup> shows the ratio between the two types.

When the swelling has reached the final size of the oögonium, the adjoining parts of the hypha are densely filled with plasm. After a short time (10–30 minutes) swellings appear within the hypha and then cross-walls become visible, which separate parts of the hypha about 9–14  $\mu$  long and which will become the antheridia. In most cases 2 antheridia are present, one hypogynous and one epigynous. Sometimes only one is present and then it may be either hypogynous or epigynous. Figure 6 shows the ratio of the three possible types.

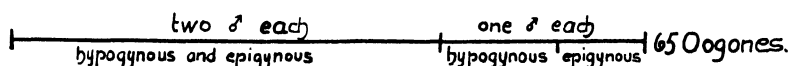


FIG. 6. Ratio for the antheridia.

The plasm within the oögone does not completely fill the oögone. It has at first a smooth outline. Very soon (see the explanation of plate 20 on page 507) the plasm-surface becomes irregular and the plasm undergoes accumulations and translocations. The result is the separation of the periplasm which degenerates.

During this time one antheridium has dissolved the oögone-wall and a part of its plasm enters. Corresponding to that one or two vacuoles appear within the antheridium. When the oögone-plasm again has a smooth outline, a tube is distinctly visible arising from the antheridium and reaching the oögone-plasm. In the meantime the second antheridium has broken through the oögone-wall and forms a similar tube. Both antheridia present

<sup>4</sup> To take the values for the graphs figures 5, 6, and 7 the third, the fifth and sixth daughter-cultures were used. Those oögonia were taken which showed clearly the necessary facts and which were found during one continued examination.

become emptied; no exception could be found. A very small remainder is left in the antheridium which soon disappears.

Then the oögone-plasm seems to enlarge. After 70 minutes the outer line of the oöspore-membrane is visible;  $1\frac{1}{2}$  hours later also the inner line. This oöspore-membrane is thicker than the oögone-membrane and measures  $\pm 1.5 \mu$ . Slow translocations of the plasm continue.

The next day an irregularly outlined, bright-shining vacuole is surrounded by the oöspore-plasm (PLATE 20, FIG. 9) which is the first sign of the development of oil-drops. The next two days no progress could be seen. In an attempt to influence it, the window was left open over the cold night. After the second night in both oöspores continually observed the formation of the oil-drop was finished. They were smaller than the inner vacuole already present (PLATE 20, FIGS. 9 and 10).

The development of the oil-drops may take some weeks. After 9 weeks a number of oöspores can be found in which they are not yet finished. For a longer time a labile balance seems to exist and the possibilities are either oil-secretion or dissolution. However the formation of oil-drops is not absolutely necessary before germination takes place. Both kinds of oöspores have been seen germinating. My dates suggest that those oöspores without fully developed oil-drops germinate more readily for the dissolution of oil-drops is not necessary. But my notes also suggest that the oöspores with fully developed oil-drops are more resistant to environmental conditions.

Similar observations among Saprolegniaceae and *Allomyces* suggest furthermore, that the complete secretion can be accelerated by external factors. The brown resting-spores of *Allomyces* for example react to contact. If we carry them with a needle over on to agar, regularly one or a few oil-drops are secreted immediately. In other cases the temperature seems to be influential.

Either one or two oil-drops were found within the oöspores of *Pythium epigynum*. They are always surrounded by plasm and located slightly excentrically or close to the periphery. The outside structures of *Achlya oblongata* or *Pythiopsis cymosa* as drawn by Coker never occur.

The graphs in figure 7 show the diameters of the oöspores and oögones. The third, fifth and sixth daughter-cultures were used for these measurements.—Both oöspore- and oögone-curves were brought on one abscisse in order to have an illustration for the terms “oögone-filling” and “not filling.” Ever since the establishment of the genus this has been a criterion and is used today. These two curves have a small common field *A-B-C*, which grows

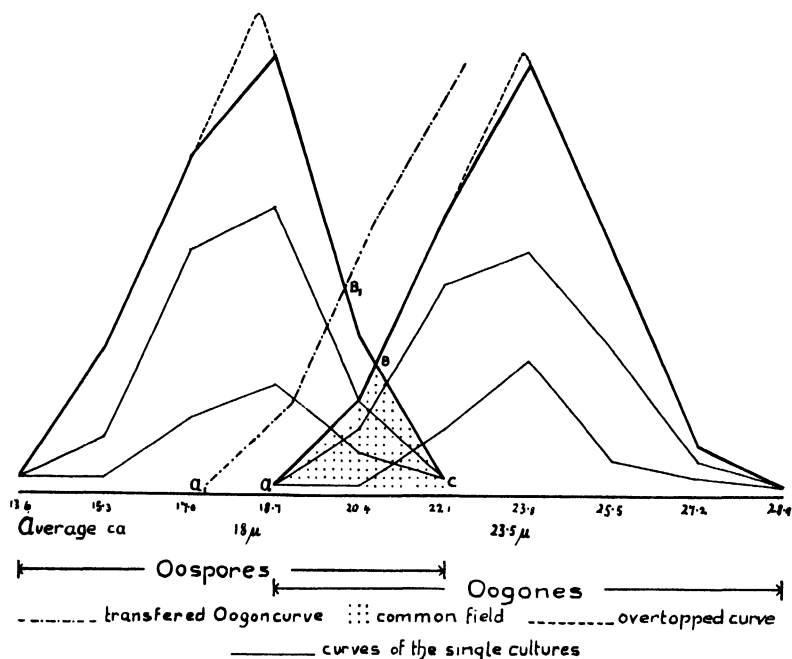


FIG. 7. Graph showing the average-diameter of oöspores and oögones. Explanation in the text.

slightly when the double thickness of the membrane is subtracted, which in this case is  $1.5\ \mu$ . The common field is now *A<sub>1</sub>-B<sub>1</sub>-C*. It follows for *Pythium epigynum*: in most cases the oöspores do not fill the oögonia although some can be found which do fill the oögonium.

Two times an oögone was found each containing two oöspores. The latter were in these cases of different size and not spherical (PLATE 20, FIG. 12).

The germinating eggs observed formed a tube which branched. These hyphae are able to infect or to form sporangia, which have been shown to be of the same behavior as those described above.

### PARASITISM

When the above observations had been carried out the following experiments were made in order to see whether *Pythium epigynum* is a parasite.

For this purpose an apparatus used here in the physiology course was modified (FIG. 8).—The water from the faucet ran slowly but constantly into a suction-flask, which stood on a heater. The water temperature fluctuated between 70°–95° C.

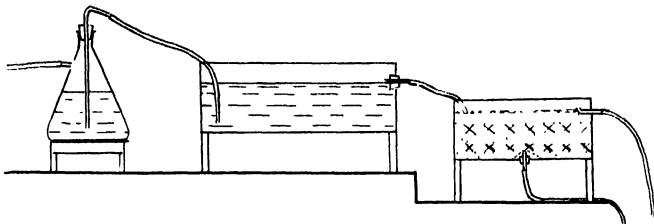


FIG. 8. Explanation in the text.

Thereby the possible fungus-spores within the water were killed. From here the heated water ran first into a covered water-container and then into a soil-case. The latter case contained soil, humus xxx and sand . . . (both sterilized for several days within the autoclave) in several layers. An outlet kept for the first two days a water-layer 1 cm. in depth and then by the turning of the bent outlet the water-surface was lowered.

The average water-temperature within the water-container was about 24° C., while it was 19–23° C. within the soil-box. The latter temperature favors the seed-germination as well as fungus growth.

The seeds on the surface of the soil developed naturally. After a few days the radicula of peas and beans grew to a length of 0.4–0.9 cm. No disturbances were recognized. Then 4 wefts of *Pythium epigynum* on ant-larvae were brought into the water. After two to three days the germinating seeds were attacked and the fungus mycelium covered almost the whole soil-surface.

Those seeds which lay close to the ant-larvae died first. Those at a greater distance followed about 1 day later. Figure 9 gives a photograph of seeds being  $4\frac{1}{2}$  days in water.

Grass-seed had been added at the same time. They germinated after 5 days. They developed naturally and seemed to be resistant. Later on, after 10-12 days, some collapsed. They were surrounded by a thick weft of the fungus but only one of the examined plants showed real infection. The hypocotyl was attacked. The hyphae coming from the plant formed a dense mass of vegetative propagation-organs. Here no sexual organs were found until the 14th day, while they have been found on peas and beans after 8-9 days.

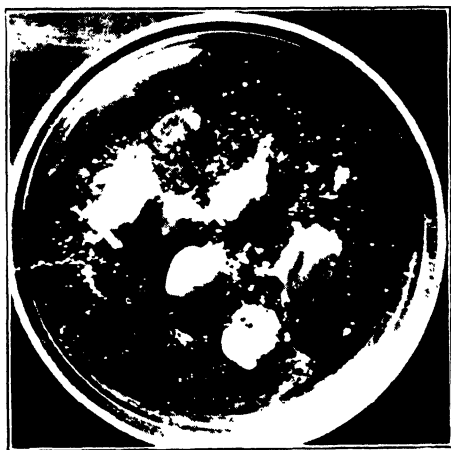


FIG. 9. Peas and beans affected by *P. epigynum*.

The parasitism of this species was confirmed by trials within flower-boxes. These boxes contained a mixture of  $\frac{2}{3}$  sand and  $\frac{1}{3}$  black humus, both parts having been sterilized several times. Grass seed, wheat, rye, corn, oats and barley were grown. After 15 days one fungus-weft was brought on the soil-surface of each box and kept moist by watering. Among these the corn-seedlings were attacked by the fungus. Discoloration of the plant appeared at the soil-surface. After 5 weeks the fungus was found within the root as well as on the stem and leaves.

Fungus-cultures, obtained from the affected seeds and seedlings proved *Pythium epigynum* to be a parasite.



## TAXONOMY

This oömycete belongs to the genus *Pythium* and furthermore to the sub-genus *Sphaerosporangium* (Fischer). It is characterized by the facts that only hypogynous and epigynous antheridia are present, that the oögones and oöspores differ in size and shape from related species and that production of so-called gemmae is found frequently. For the nearest related members of this group a scheme for comparison is given on page 505.

Epigynous antheridia have not been reported until recently. Matthews has figured for *Pythium pulchrum* v. Minden in plate 21, figure 4, 2 hypogynous antheridia. One of them might be an epigynous one. But she states the antheridia are hypogynous, androgynous or diclinous. Also von Minden (1916) might show on plate 6, figure 53 an epigynous one. However, because he states the antheridia are hypogynous, androgynous and diclinous, it might as well be a diclinous one since a similar figure of *Pythium Debaryanum* is shown, but it is stated as one hypogynous and one diclinous antheridium. In addition to that, *Pythium pulchrum* v. Minden differs distinctly in all other respects from *Pythium epigynum* (also the oögone and oöspore-measurements of Matthews are still larger than those of v. Minden).







A similarity seems to be present in *Pythium rostratum* Butler. But just the characteristics pronounced as important by Butler are different. He says of *Pythium rostratum* that the hyphae are "never prolonged into fine filaments" and "the oögonium is completely filled by the oöspore, . . . this is a character of specific value in the Pythiaceae. . . ." Furthermore compare both species on page 505 or Butler's text.—Confusion with *Pythium vexans* is scarcely possible.

On page 505 *Pythium Debaryanum* Hesse is not given. This species was also isolated and compared with *Pythium epigynum*. The typical growth under the same conditions and on ant-larvae is different. The hyphae of *P. Debaryanum* grow longer than 2 cm. and aërial hyphae are formed. Also the septation in old hyphae is much more common and appears in *P. Debaryanum* in the thick main-hyphae as well as within the branches. An empty neck is never found below the sporangium in *Pythium epigynum*. The "conidia" or resting-sporangia are smaller in

*P. Debaryanum* and the oögones are mostly terminal while in *Pythium epigynum* mostly intercalary (FIG. 5). Furthermore, a graph like that given in figure 7 drawn for *P. Debaryanum* would be strikingly different because the oöspores measure 14–18  $\mu$  and the oögones 20–25  $\mu$ .

*P. artrotogus*, which forms also one hypogynous antheridium is in its appearance quite different.

Therefore this fungus is described as a new species.

	<i>P. pulchrum</i>	<i>P. epigynum</i>	<i>P. prostratum</i>	<i>P. vexans</i>
Hyphae	diam 3–5 $\mu$	diam 5–8 $\mu$ gradually getting thinner prolonged into fine filaments	diam 6–8 $\mu$ never prolonged into fine filaments	Branches are fine filaments
Sporangia	 terminal and intercalary, rows a clusters spherical and oval thin membrane collaps- ing when empty short tube	 intercalary seldom terminal spherical and oval consistent membrane, long tubes, twice the sporangium-diameter  Gemmae	 terminal seldom intercalary spherical and ovoid consistent membrane, tubes equal the sporang- ium-diam  Gemmae rare seen once	Missing de Bory seldom Butler, term or intercalary  irregular pear-shaped short tubes "Conidia"
Oogonia	terminal and intercalary spherical 23–31 $\mu$ mostly 28 $\mu$	intercalary seldom terminal spherical 19–29 $\mu$ mostly 23 $\mu$	intercalary and lateral transv diam 21 $\mu$ longit " more	lateral broad inserted 22–25 $\mu$
Oospores	Oogone not filling 21–24 $\mu$ , mostly 18 $\mu$	Oogone not filling 14–22 $\mu$ , mostly 18 $\mu$	Oogone completely filling 12–26 $\mu$ , mostly 21 $\mu$	Oogone not filling 20–22 $\mu$
Antheridia	hypogynous and androgynous, seldom diclinous	mostly 2, hypogynous und epi- gynous	single, androgynous, seldom hypogynous	1, seldom 2, androgynous, seldom hypogynous

### *Pythium epigynum* sp. nov.

Fungus generat intra 2–3 dies circum nympham mycelium cum radio 1–15 cm. Hyphae singularis graciles et ramosae sunt et crassae 5–8  $\mu$ . Rami attenuati sunt secundum ordinem. Apices filamentosa sunt.

Zoösporangia port 24 horas oriuntur, plerumque intercalaria, rarissime terminalia. Forma eorum globosa aut ovota est. Sporangia globosa diametros 29  $\mu$  (21–34  $\mu$ ) habent; ovata 19–24  $\mu$  longa sunt et 22–29  $\mu$  crassa.—Plasma per tubulum longum exit et ante orificium sporangii in vesicula manet. Nunc zoöspora oriuntur quarum utraeque ciliis duas lateralis et vacuolam unam contractilem habent. Formatae, versicalem dirumpunt et per 10–30 min. emanant. Deinde requiescunt, rotundatae mem-

branam formant. Singulariter bis emanant. Tum germinant.—His sporangiis primis sporangia perdurantia forma et magnitudine fere similia sunt. Evacuatio eorum aut fit aeque illis aut plerumque germinant. Si nutrimentum adest utriculi inficiunt aut in aqua recente zoösporangia producunt sive rursus sporangia perdurantia.

Organa sexualia iam post 36 horas oriuntur. Oögonia plerumque intercalaria, rarius terminalia sunt. Diametros eorum 19–29  $\mu$ , in media magnitudine 23.5  $\mu$ .

Antheridia semper adsunt, plerumque dua, et hypogynum et epigynum. Utrumque antheridium in oögonium evacuatur. Rarius antheridium unum solum oritur; aut hypogynum aut epigynum. Longitudo eorum 18  $\mu$  est.

In hyphis veteribus plasma in partes breves contracta septis transversalibus separatur. Gemmae nominantur; cum utriculo germinant qui inficere potest et zoösporangia aut sporangia perdurantia producere.

Fungus ex particula soli separatus est quae ex ripa lacus pratensis apud Milton, Wisconsin excepta erat. Fundus luto sabulosa constans sine vita plantae erat, campus graminosus 3 m. distat.

I am indebted to Dr. F. M. Gilbert for his advice and assistance during the preparation of this paper.

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PYTHIUM EPIGYNUM



## EXPLANATION OF PLATE 20

Figs. 1-10 are taken from the same oögone under continued observation:

Oct. 24, 1931

1, 10:14 A.M. young, not yet separated swelling; 2, 1:40 P.M. crosswalls are formed; 3, 2:25 P.M. the oögone plasma has become irregular. Between stripes and balls of thick plasm bright, hyaline spaces are visible. The hypogynous antheridium is separated, the epigynous one is going to be formed; 4, 3:25 P.M. the oögone-plasma is at the highest point of action. The periplasm seems to be already formed. The hypogynous antheridium penetrates the oögone-membrane, the epigynous one shows the cross-wall; 5, 4:02 P.M. the oögone-plasma is differentiated. The inner becoming oöspore-plasm is surrounded by the periplasm. The hypogynous antheridium forms the tube to the egg plasm and the growth of the vacuole suggests the entering of the plasm; 6, the mouth-like swelling of the oöspore-plasm and differentiation within the periplasm. 7:05 P.M. the oöspore-plasm is surrounded by a bright shining circle; the outer wall of the oöspore-membrane is visible, which cuts off the antheridial tubes. The content of both antheridia has entered into the oöspore, and only a small remainder is left. Near the center a refractive vacuole.

Oct. 25, 1931

8, 1:00 A.M. the oöspore-membrane is ready. The plasm is becoming more and more homogeneous.

Oct. 26, 1931

9, 10:05 A.M. the plasm secretes reserve material into the inner space. (The bright shining vacuole wandered to the left side.)

Oct. 28, 1931

10, 8:12 A.M. the central oil-drop is formed. The adjoining parts of the hypha are empty.

11, One oöspore with two oildrops; 12, One oögonium with 2 öospores of different size.

## THE GENUS PROTODONTIA

G. W. MARTIN

(WITH 2 TEXT FIGURES)

In 1895, Möller described the genus *Protohydnum*<sup>1</sup> from Brazil, with the single species *P. cartilagineum*, described as resupinate, yellowish white, and thickly beset with blunt spines attaining a length of 5 mm. This description is confirmed by an accompanying photographic illustration (PLATE 3, FIG. 1). The basidia are divided longitudinally into four cells, each cell producing an epibasidium tipped by a sterigma and bearing an elongated, oval spore  $9 \times 4-5 \mu$ . In 1903 Bresadola doubtfully attributed to this genus a second species, found in Poland, as ?*Protohydnum lividum*.<sup>2</sup> This species was clearly distinct from Möller's, being livid fuscous to vinaceous fuscous, waxy membranous in texture and with small, acute spines about 0.5 mm. in length, with sterile tips, the spores subglobose to obovate, depressed on one side and with a large guttule,  $5.5-8 \times 4-5 \mu$ .

In 1907 von Höhnelt described the genus *Protodontia*<sup>3</sup> to accommodate a fungus with the aspect of *Odontia* but characterized by longitudinally septate basidia. This species, named *P. uda*, was described as yellowish or reddish yellow, with short spines 0.2-0.4 mm. long, and with broadly ovate spores, flattened on one side,  $6-8 \times 4-5 \mu$ . Rea<sup>4</sup> reports this species as rare in Britain, using von Höhnelt's name, but noting that it is pure white when fresh, and giving the spore measurements as  $6-8 (-9) \times 3-4 \mu$ . Bourdot and Galzin,<sup>5</sup> on the other hand, regard this species as identical with that of Bresadola, use his name, and report its occurrence in France. They describe the color as "grayish hyaline, a trifle bluish," the spines livid-fawn when dry, the spores ovoid, somewhat depressed laterally,  $5-9 \times 4-6 \mu$ . They also describe a form *microdon* with slender, short spines

<sup>1</sup> Protobasidiomyceten 131. 1895.

<sup>2</sup> Ann. Myc. 1: 117.

<sup>3</sup> Sitzungsber. Acad. Wien. 116: 83.

<sup>4</sup> British Basidiomycetae 736. 1922.

<sup>5</sup> Hymenomycètes de France 1: 34. 1927.

and spores  $6-7 \times 3-4 \mu$  and a var. *furfuracea* from France with white, furfuraceous-pulverulent subiculum and spores  $5-7 \times 3-4 \mu$ .

It will be observed that there is some confusion between these various descriptions. It seems clear, however, that *Protodontia* is sufficiently distinct from *Protohydnum* to be maintained as a valid genus. Whether von Höhnel's species is the same as the forms described by Rea using von Höhnel's name is not certain, but seems probable, as slight variation in spore size and color is not of great significance in the Tremellales. That Bresadola's species is the same is very questionable, the differences in color and habit being too great. It may not belong to either *Proto-*

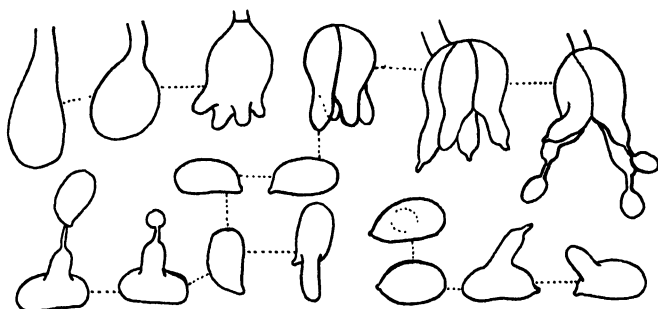


FIG. 1. Basidia and spores of *Protodontia uda* v. Höhn. Above, six basidia in successive stages of development; below, ten spores, five in various stages of germination,  $\times 1500$ . The dotted lines indicate that the figures so connected are from the same fructification.

*hydnum* or *Protodontia*. The description of *Protohydnum lividum* Bres. and its variants, as given in Bourdot and Galzin, is rather broad, but would seem to refer to von Höhnel's species and not to Bresadola's.

We have several collections from Iowa of a fungus with the aspect of *Odontia*, but of subgelatinous consistency and bearing in its hymenium typical tremellaceous basidia. The fructification is resupinate, with indeterminate margins, the subiculum waxy, very thin, sometimes continuous but commonly broken or reticulate, especially near the margins. The spines are white, waxy, slender, approximately terete, 0.1 to 1 mm. in length, occasionally longer, and usually more or less branched, appearing fimbriate under a lens (FIG. 2); the larger spines are often sterile,



evidently because the basidia have discharged their spores and collapsed. The basidia are clavate, the swollen part nearly globose,  $12-14 \times 5-6 \mu$ , becoming longitudinally septate, each of the four divisions producing a rather short epibasidium bearing a spore in the usual fashion (FIG. 1). The spores are oval or short cylindric, slightly curved,  $5-7.5 \times 2.5-4 \mu$ , germinating by repetition. The fructifications are watery white or grayish white when fresh, drying yellowish. They are usually small, 1-3 cm. broad, but one collection was over 10 cm. long and half as wide.



FIG. 2. Hymenium of *Protodontia uda*, showing character of spines. About  $\times 15$ .

In spite of the somewhat smaller spores I am inclined to believe our species is merely a local variation of *Protodontia uda* von Höhnelt, possibly nearer the var. *furfuracea* than to the typical form. The resemblance to *Odontia* is superficial, as the branches of the spines are of the same structure as the main axis, being composed of nearly parallel hyphae which are terminated by the basidia borne along the sides. There is no trace of cystidia.

It seems clear that *Protohydnum* should be retained for forms with a distinct context and blunt, finger-like spines, while species

with acute, fimbriate spines borne on a scanty subiculum are better referred to *Protodontia*. The species described and illustrated by Albertini and Schweinitz as *Hydnum fasciculare*<sup>6</sup> was transferred by Fries to *Mucronella* and by Bresadola<sup>7</sup> to *Protohydnum*, in which genus it is retained by Bourdot and Galzin. It is certainly distinct from *Protodontia uda* and is not a *Protohydnum* in Möller's sense as that is here interpreted. The *Mucronella*-like clusters of spines, connected merely by what Bresadola calls a pseudo-subiculum, may even justify its generic separation from *Protodontia*. Killermann<sup>8</sup> recognizes both genera, but his diagnoses are brief and of little help. He includes only the one species in *Protodontia*, *P. uda*, while in *Protohydnum* he includes with Möller's original species, *P. cartilagineum*, both *P. lividum* and *P. fasciculare*.

A collection in the herbarium of the Missouri Botanical Garden (M. B. G. 63156), determined by Burt as *Protohydnum lividum* Bres. was collected by Langlois in Louisiana and labelled by him "*Exidia glandulosa?*". It has a well developed, separable context bearing a continuous hymenium, with a very few widely scattered, minute teeth. In color it is vinaceous livid when moist, drying to a thin, horny, reddish crust. The spores are elongate, slightly curved,  $12-14 \times 5.5 \mu$ . Except for the few spines, it would be a typical *Sebacina*. It certainly does not agree with Bresadola's description.

The Iowa collections are from three distinct localities, one, in Dubuque County, separated by over a hundred miles from the other two, in Johnson County. In addition we have a portion of a collection from Louisiana, gathered by Mr. Clair A. Brown (No. 344) at Sorrento, which is apparently the same species, although the teeth are somewhat less fimbriate and there are insignificant differences in spore dimensions. It seems probable, therefore, that *Protodontia uda* is widely distributed and not uncommon, but is passed over by collectors as a poorly developed or weathered *Odontia*.

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<sup>6</sup> Consp. Fung. 269. 1805.

<sup>7</sup> Ann. Myc. 18: 63. 1920.

<sup>8</sup> In E. and P. Nat.-Pfl. 2 ed. 6: 118-119. 1928.

## THE VIABILITY OF CULTURES OF RHIZOPUS NIGRICANS

EVELYN I. CARPENTER

From time to time, various investigators have given data, either directly or indirectly, which provide some information concerning a possible time period during which cultures or spores of fungi may retain their viability. Povah (2) has shown that cultures of fungi which fail to grow when transferred to fresh agar slants may do so when given a certain hot agar treatment. This proves that the longevity of a culture is not necessarily correlated with the success or failure to obtain a subculture by means of a simple transfer of spores or mycelium, and therefore the latter condition should not be used as a criterion of the lack of viability.

It was while procuring information as to the longevity of certain cultures that the results here presented became evident. These the writer wishes to contribute as her mite to the gradual accumulation of data.

On December 16, 1926, Professor Don M. Benedict, College of Forestry, Syracuse University, received from Dr. A. F. Blakeslee cultures of the plus and minus strains of *Rhizopus nigricans* Ehr. to replace those which were supposedly lost. These cultures consisted of mycelium and spores folded in the customary sterile paper packets. Since it became unnecessary to use the cultures, they were filed away with Dr. Blakeslee's letter inclosed. On March 2, 1932, these packets, still unopened, were turned over to the writer, who transferred the contents to sterile Blakeslee's dextrose-malt-agar slants. The material comprising the plus strain was distributed between two such slants, while only one transfer could be made of the minus strain. Within four days both tubes containing the plus strain showed the characteristic growth of *Rhizopus nigricans* Ehr. The tube to which the minus strain had been transferred failed to show the presence of any growth.

Since, in making the sub-cultures, both mycelium and spores were transferred, there may well arise the question, whether growth resulted from the spores or the mycelium or both. In view of this fact, the packet in which the plus strain had been kept was carefully re-examined, and an abundance of free spores was found. These spores were transferred to sterile slants, especial care being taken to transfer no mycelium. After eight days there were no signs of growth. Benedict, in an unpublished paper, suggests a modification of Povah's hot agar method. Sterile distilled water, boiled for three minutes and allowed to cool for five minutes, was found to revive old cultures of *Coprinus sterquilinus* Fries. Therefore, a small amount of sterile distilled water, which had been previously heated to the boiling point and cooled for four minutes, was poured over the spores on the slants. A check was made to prove that water at this temperature does not kill viable spores. Three days later, there was still no evidence of growth. Povah's hot agar treatment likewise failed to stimulate the spores to germinate. Miss Ferguson (1) working with *Agaricus campestris* (L.) Fries, found that germination of spores was best and most constant when living strands of the mycelium of the same fungus were present. In order to indicate that any growth which might occur would be from spores only, mycelium, killed by heating, was added to one of the above slants. Still no growth resulted. While spores have long been considered the means by which unfavorable periods are bridged, still it is equally certain that fungous mycelium has a greater resistance to unfavorable conditions than is commonly supposed or accepted. The writer hopes in the future to offer precise data in support of this assertion.

The resumption of growth by the plus culture used in this experiment occurred after a time interval of five years, two months and three days. This growth resulted from a transfer in the usual fashion, without any stimulation other than a medium at normal room temperature. The longest time interval recorded by Povah (loc. cit.) for cultures of *Rhizopus nigricans* Ehr. is less than one year (eleven months and six days). The writer believes that many mycologists could record periods of over one year during which cultures of *Rhizopus nigricans* Ehr. have remained

viable. The query therefore arises whether it was necessary for Povah to use his hot agar treatment in order to revive his culture. For, if cultures of this fungus, of less than one year, will not produce viable transfers without the hot agar treatment, then they must have been subjected to severe desiccation or other extreme factors.

Within the writer's knowledge there is no recorded time interval for a single culture of *Rhizopus nigricans* Ehr. longer than the one found in this experiment. It is therefore believed that the results obtained impart important mycological information.

This discussion leads to the following conclusions:

1. Data concerning the longevity of cultures, spores or mycelium, based upon simple transfers are not reliable. This is indicated in Povah's paper and further proof is evinced in the experiment here stated.

2. This experiment does not prove that the spores did not germinate in the presence of the mycelium, but no germination of the spores resulted in its absence.

3. The mycelium definitely retained its viability for the time interval of five years, two months and three days, and is the important factor in the longevity of cultures of *Rhizopus nigricans* Ehr.

The writer is indebted to Mr. Benedict for the material used in this investigation, and for the suggestion which has resulted in its completion.

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1. **Ferguson, M. C.** Germination of the spores of *Agaricus campestris* and other basidiomycetous fungi. Bur. Plant Ind. U. S. Dept. Agr. Bull. 16. 1902.
2. **Povah, A. H. W.** Notes upon reviving old cultures. *Mycologia*, 19:317. 1927.

## NOTES AND BRIEF ARTICLES

Dr. J. C. Arthur is preparing a "Manual of the Rusts of the United States and Canada," and will be pleased to receive specimens which add to the information in the seventh volume of the North American Flora. The new work will depart materially from the treatment in the N. Amer. Flora, in a way to render it more generally serviceable, and also to include illustrations.

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### The Mycological Society of America

At the last winter meeting of the Botanical Society of America, held at New Orleans, the Mycological Section formed a new society, The Mycological Society of America. The officers of the new organization are president W. H. Weston, jr., secretary-treasurer H. M. Fitzpatrick, and councilors H. S. Jackson, C. R. Orton, and Neil E. Stevens. The Society will hold its first meeting at Atlantic City, December 28-30, in affiliation with the American Association for the Advancement of Science.

As the new Society was formed near the end of the New Orleans meeting, and many who were interested were not present, it is hoped that there will be a full attendance at Atlantic City. A business session will be held Wednesday morning, December 28, at which it is expected that action will be taken on the proposition of the adoption of MYCOLOGIA as the official organ of the Society. A tentative contract has been drawn up between the officers of the Society and the New York Botanical Garden, which will be offered to the Society for its approval. By the terms of the contract the journal will continue to be published by the New York Botanical Garden, but the editorial policies will be controlled by the Society.

Membership application blanks are being mailed to all members of the former Mycological Section of the Botanical Society of America, to all personal subscribers to MYCOLOGIA, and to other selected lists of names. All persons in America and abroad who are interested in mycology in any of its phases are invited to make application for charter membership. It is expected that

the annual dues will not exceed five dollars, but this will be decided by vote of the Society.

At Atlantic City in addition to consideration of business matters there will be a scientific program, with several sessions for the reading of papers. Those who wish to present papers will be provided on request with a blank form which must be filled in and returned not later than November 3 to the secretary-treasurer.

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Plant Science Building,  
Cornell University,  
Ithaca, N. Y.

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